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Yamauchi

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(54) **PAINT REPLENISHING APPARATUS FOR CARTRIDGE AND PAINT REPLENISHING METHOD THEREOF**

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B67D 7/02 (2010.01)
B05B 5/04 (2006.01)
(Continued)

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CPC ... ***B67D 7/02*** (2013.01); ***B05B 5/04*** (2013.01); ***B05B 5/1625*** (2013.01); ***B05B 5/1675*** (2013.01); ***B05B 12/1463*** (2013.01); *B05B 3/1064* (2013.01)

(58) **Field of Classification Search**
USPC 141/1, 20.5, 85, 89, 90, 91, 92, 98, 104, 141/105, 192, 279, 284
See application file for complete search history.

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Primary Examiner — Timothy L Maust
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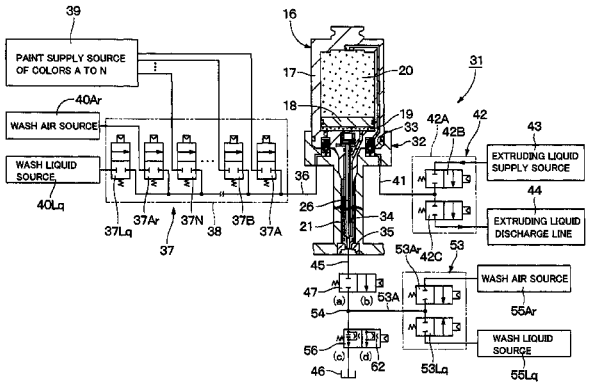
(57) **ABSTRACT**

A cartridge discharges paint in a paint chamber from a feed tube by displacing a piston in a tank. A waste liquid adjusting valve located on a downstream side of a waste liquid passage on-off valve and including a throttle passage is provided in a waste liquid passage to be connected to the feed tube. This waste liquid adjusting valve is opened at the time of washing clean the paint chamber and a paint supply passage of the feed tube to widely enlarge the passage cross-sectional area of the waste liquid passage. When paint is replenished into the paint supply passage, the waste liquid adjusting valve uses the throttle passage as a flow passage to narrowly throttle the passage cross-sectional area of the waste liquid passage. The amount of discarded paint which flows out from the feed tube is thereby reduced.

11 Claims, 14 Drawing Sheets



(51) **Int. Cl.**

B05B 5/16	(2006.01)
B05B 12/14	(2006.01)
B05B 3/10	(2006.01)

(56) **References Cited**

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Fig. 1

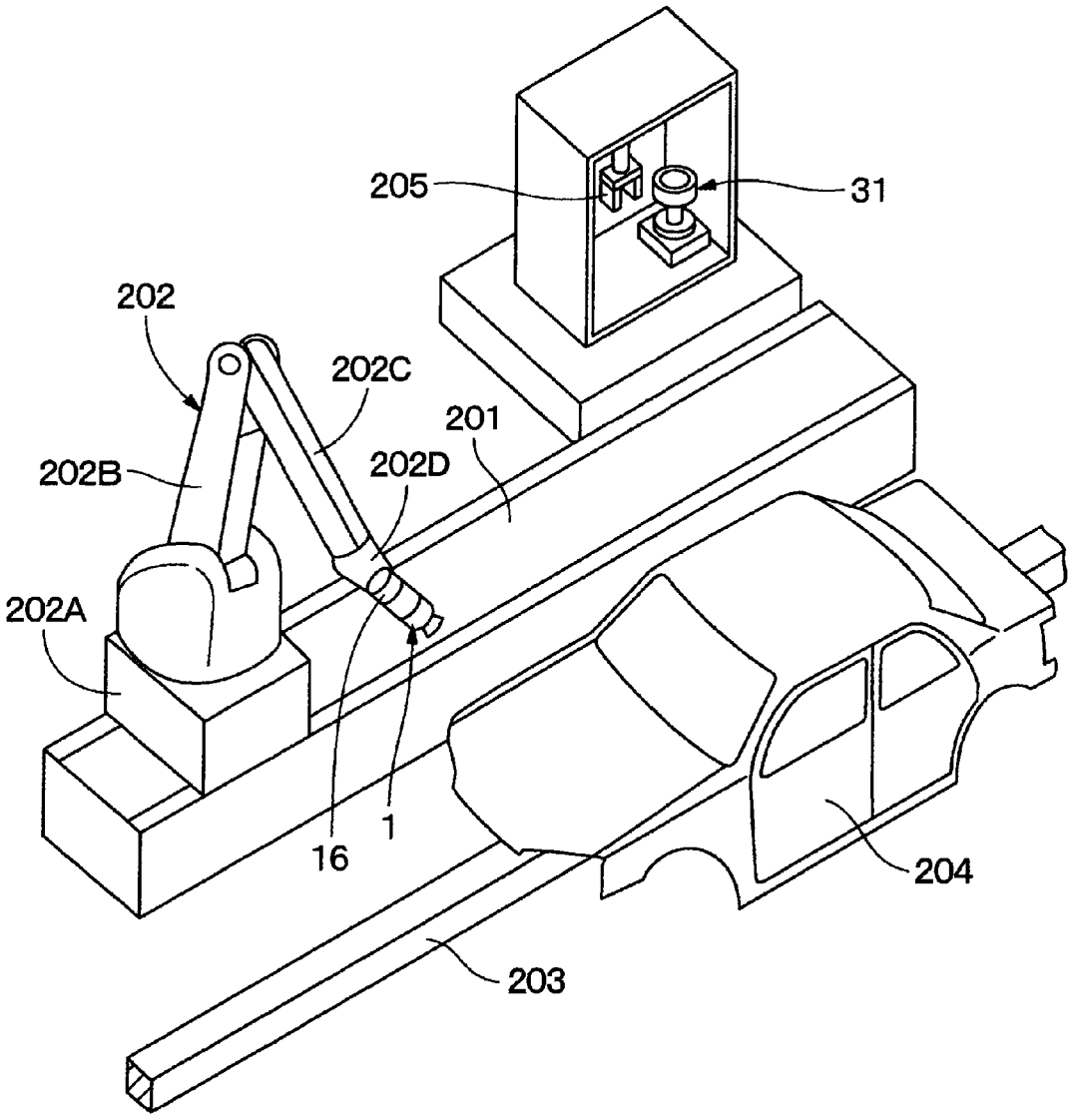


Fig.2

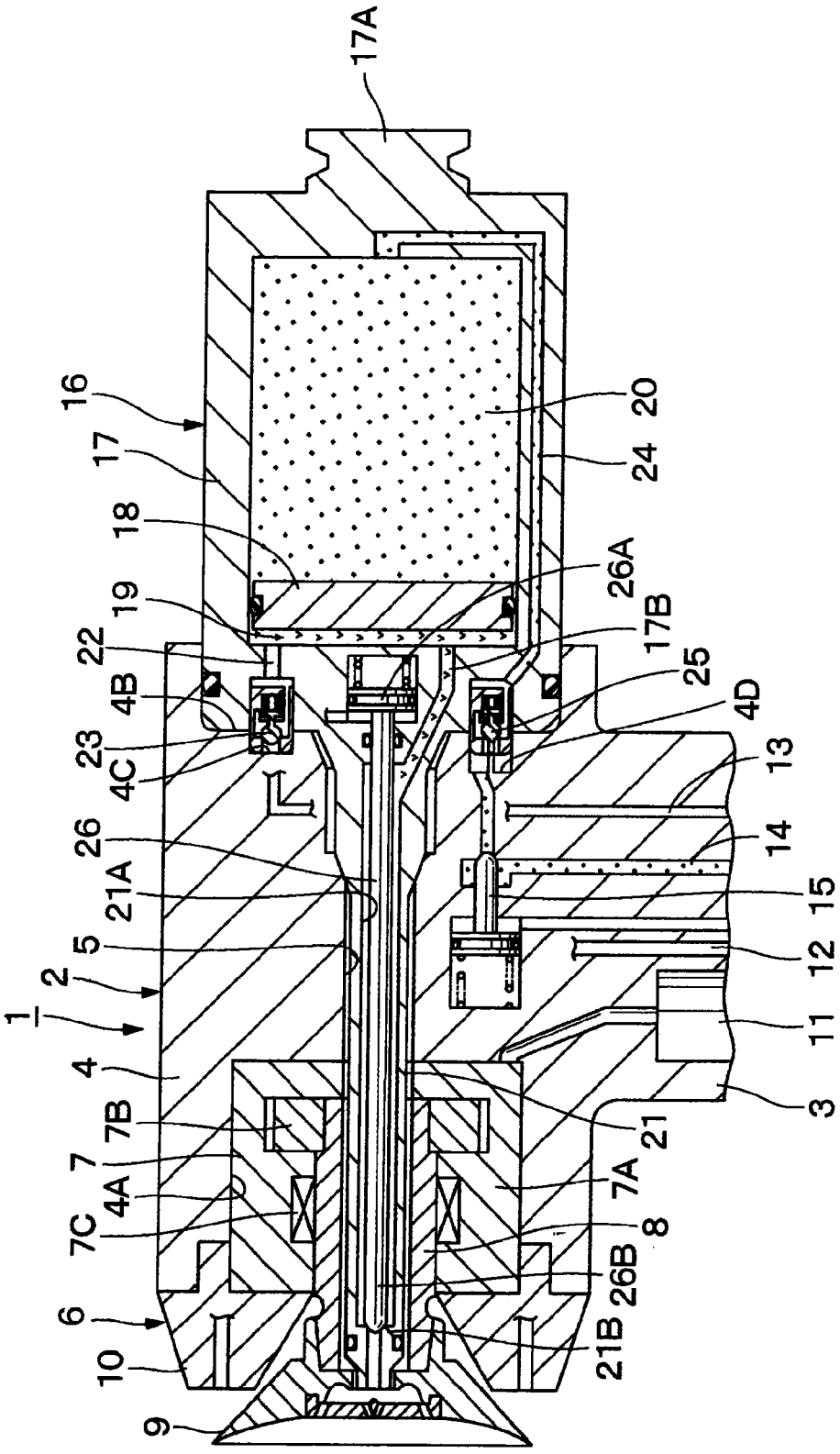

17A
16
17
18
19
22
4B
23
4C
26
21A
5
2
1
4
7B
7
4A
7C
6
10
9
20
24
26A
17B
25
4D
13
14
15
12
11
3
21
7A
8
26B
21B

Fig.3

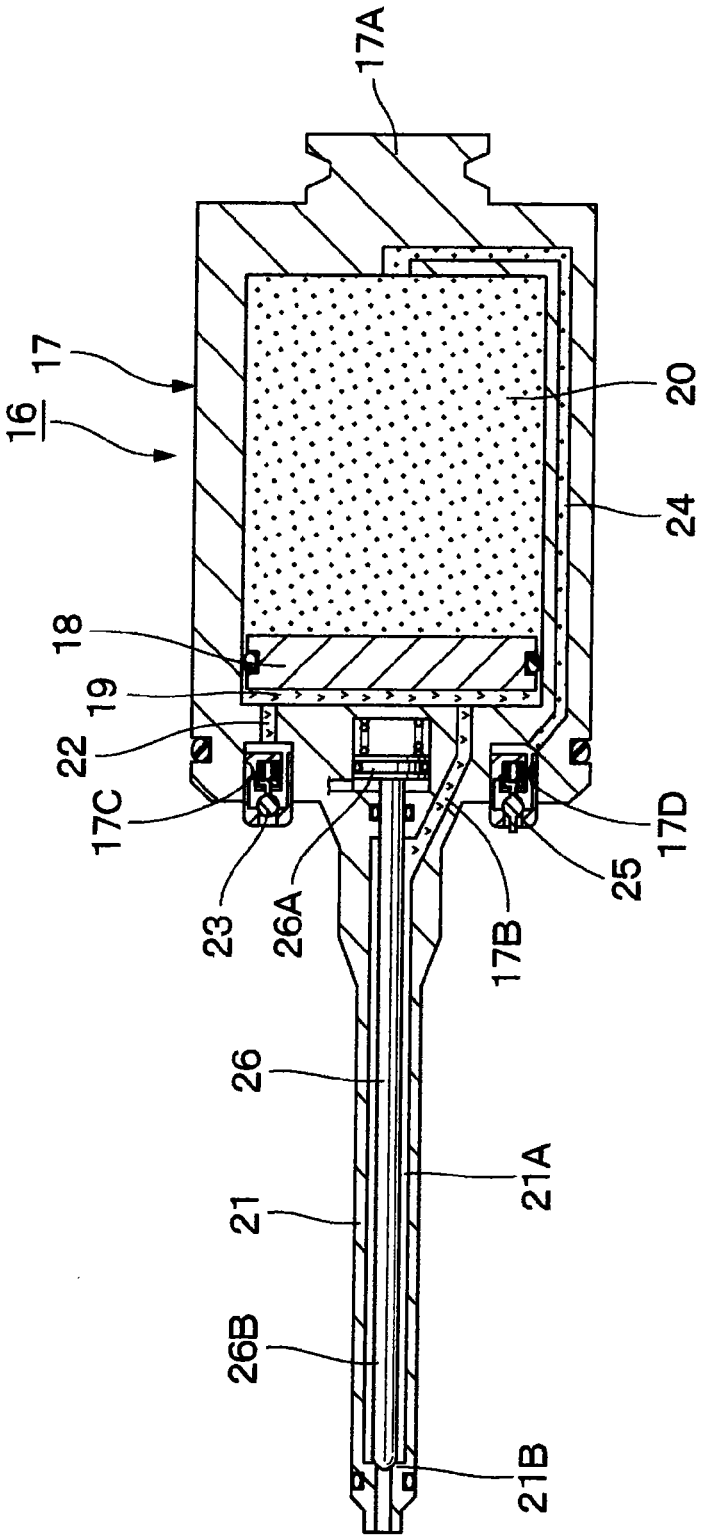


Fig. 4

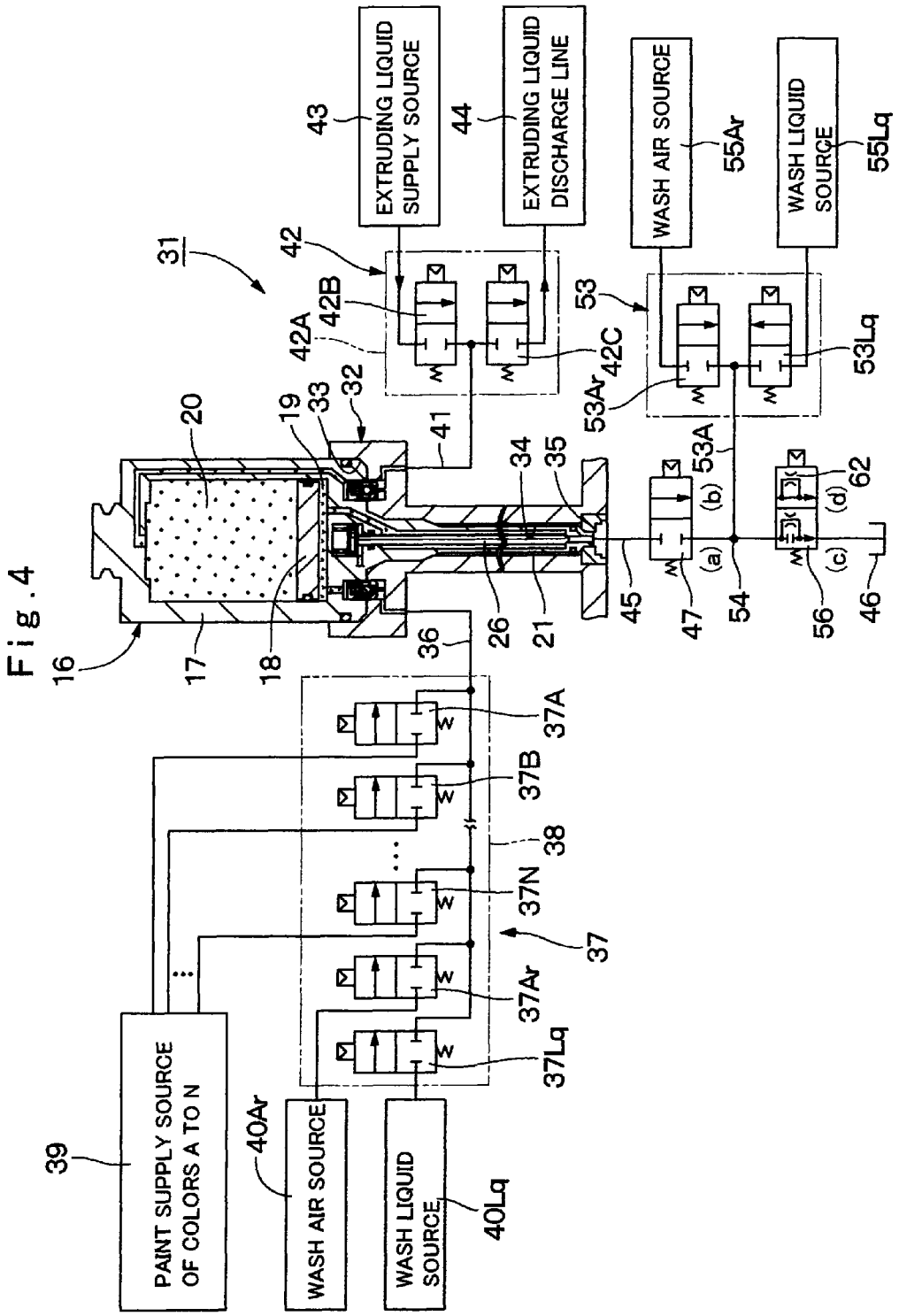

EXTRUDING LIQUID SUPPLY SOURCE
EXTRUDING LIQUID DISCHARGE LINE
WASH AIR SOURCE
WASH LIQUID SOURCE
PAINT SUPPLY SOURCE OF COLORS A TO N
WASH AIR SOURCE
WASH LIQUID SOURCE
31
42
42A
42B
42C
43
44
53
53Ar
53A
53Lq
55Ar
55Lq
16
17
18
19
20
21
26
32
33
34
35
36
37
37A
37B
37N
37Ar
37Lq
38
39
40Ar
40Lq
41
45
46
47
54
56
62
(a)
(b)
(c)
(d)

Fig.5

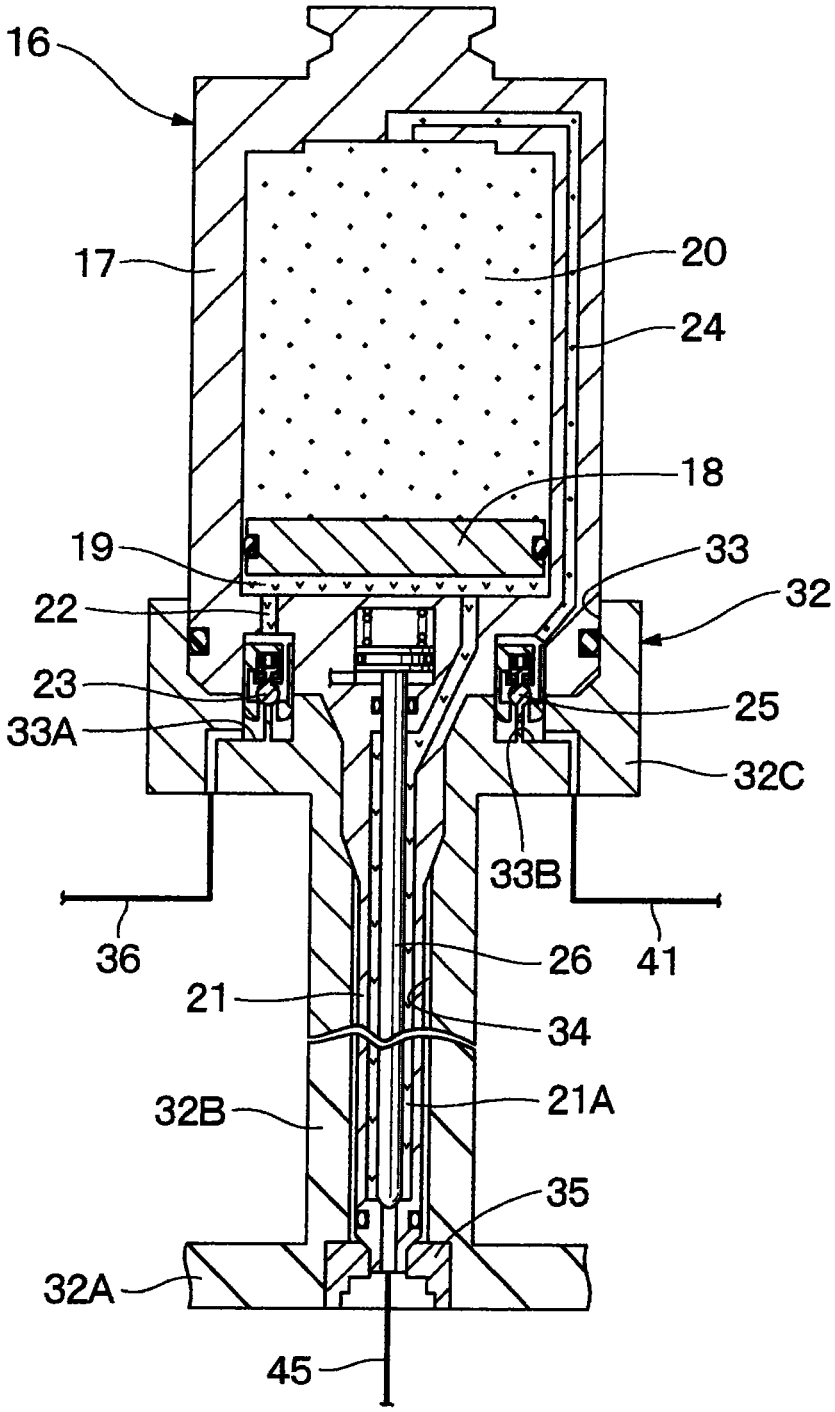

16
17
20
24
18
19
33
32
22
23
25
33A
32C
33B
36
41
26
21
34
32B
21A
35
32A
45

Fig.6

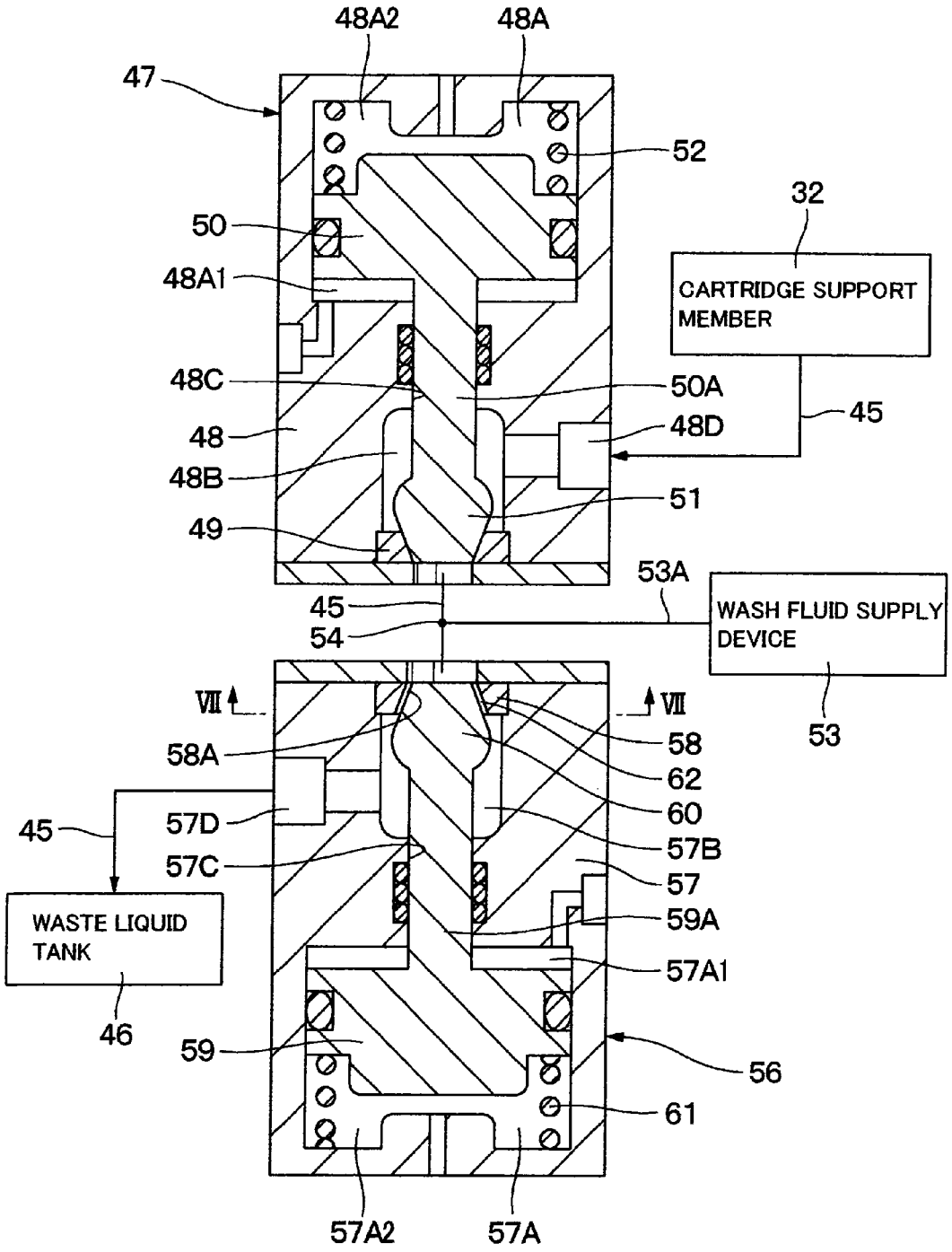

48A2
48A
47
52
32
50
CARTRIDGE SUPPORT MEMBER
48A1
48C
50A
45
48
48D
48B
51
49
53A
45
WASH FLUID SUPPLY DEVICE
54
VII
VII
58
58A
62
60
45
57D
57B
57C
57
59A
WASTE LIQUID TANK
57A1
46
59
56
61
57A2
57A
53

Fig. 7

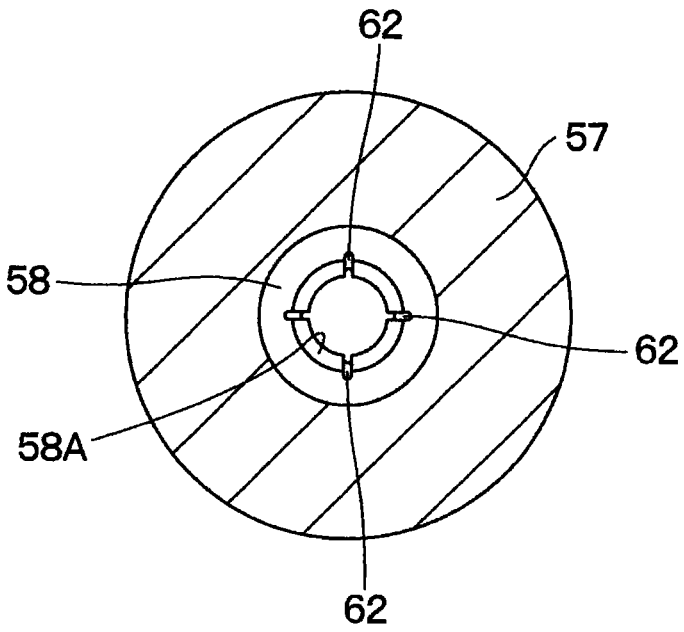


Fig.8

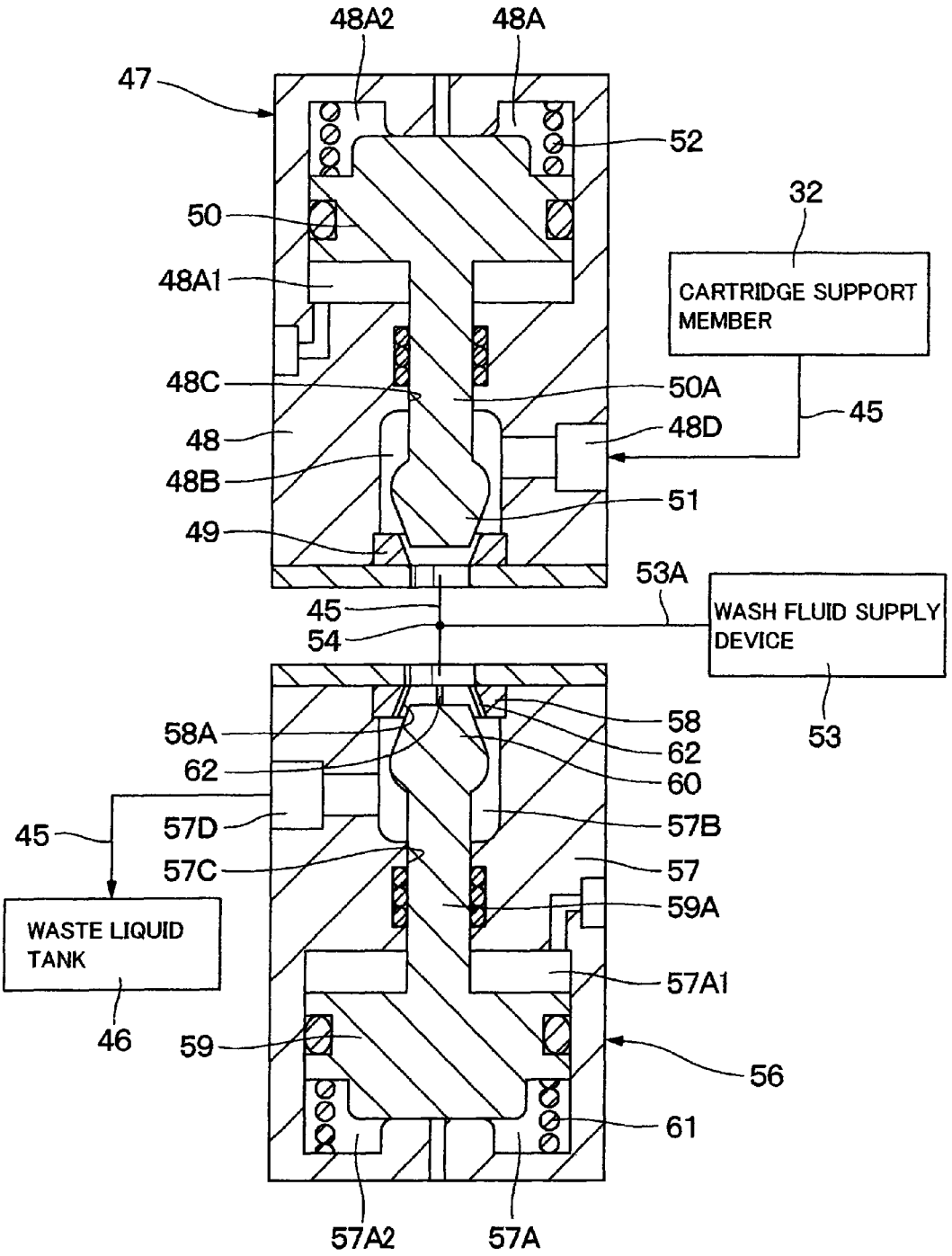

48A2
48A
47
52
32
50
CARTRIDGE SUPPORT MEMBER
48A1
48C
50A
45
48
48D
48B
51
49
53A
45
WASH FLUID SUPPLY DEVICE
54
53
58A
58
62
62
60
45
57D
57B
57C
57
59A
WASTE LIQUID TANK
57A1
46
59
56
61
57A2
57A

Fig.9

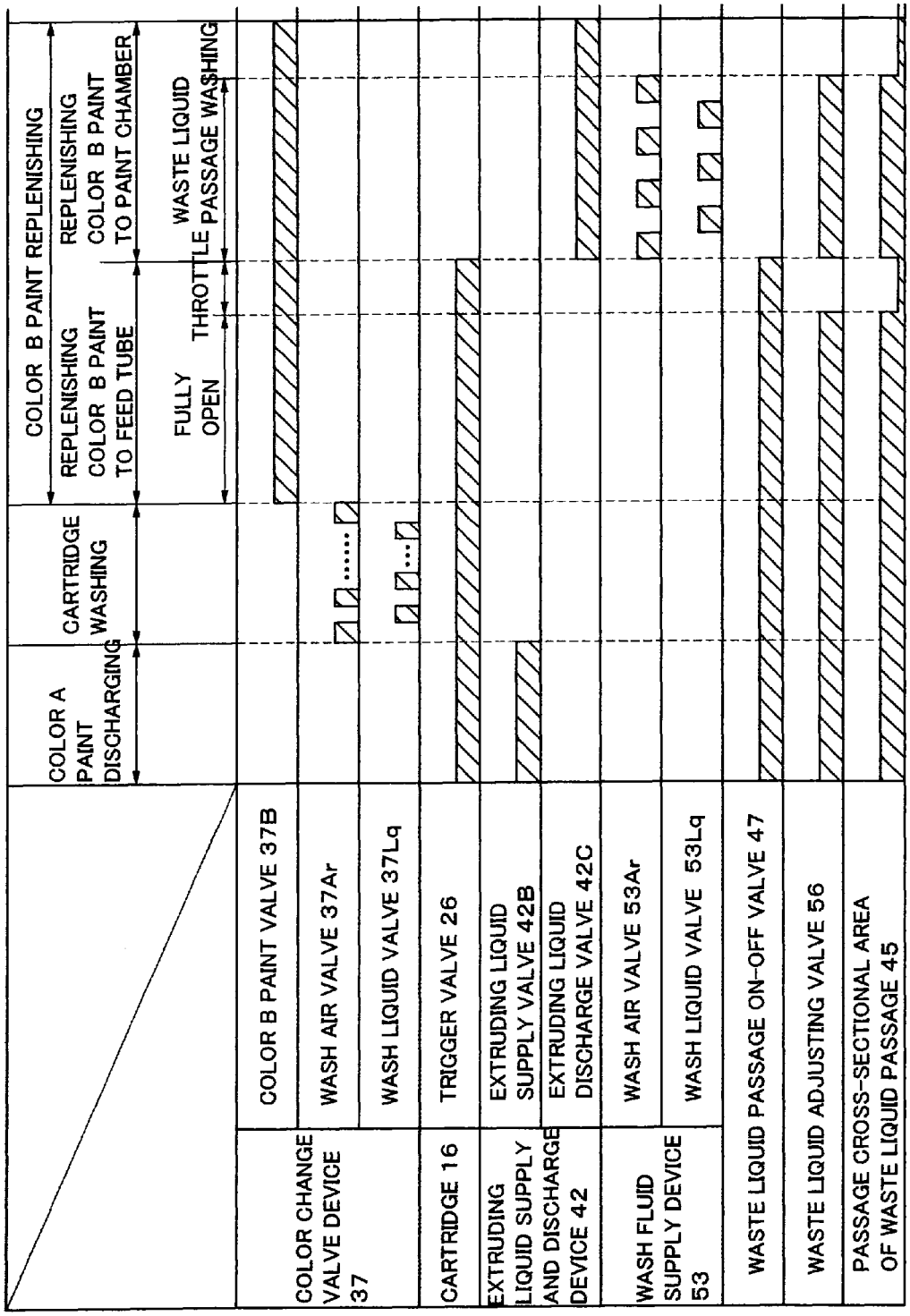

COLOR A PAINT DISCHARGING
CARTRIDGE WASHING
COLOR B PAINT REPLENISHING
REPLENISHING COLOR B PAINT TO FEED TUBE
FULLY OPEN
THROTTLE
REPLENISHING COLOR B PAINT TO PAINT CHAMBER
WASTE LIQUID PASSAGE WASHING
COLOR CHANGE VALVE DEVICE 37
COLOR B PAINT VALVE 37B
WASH AIR VALVE 37Ar
WASH LIQUID VALVE 37Lq
CARTRIDGE 16
TRIGGER VALVE 26
EXTRUDING LIQUID SUPPLY AND DISCHARGE DEVICE 42
EXTRUDING LIQUID SUPPLY VALVE 42B
EXTRUDING LIQUID DISCHARGE VALVE 42C
WASH FLUID SUPPLY DEVICE 53
WASH AIR VALVE 53Ar
WASH LIQUID VALVE 53Lq
WASTE LIQUID PASSAGE ON-OFF VALVE 47
WASTE LIQUID ADJUSTING VALVE 56
PASSAGE CROSS-SECTIONAL AREA OF WASTE LIQUID PASSAGE 45

Fig. 10

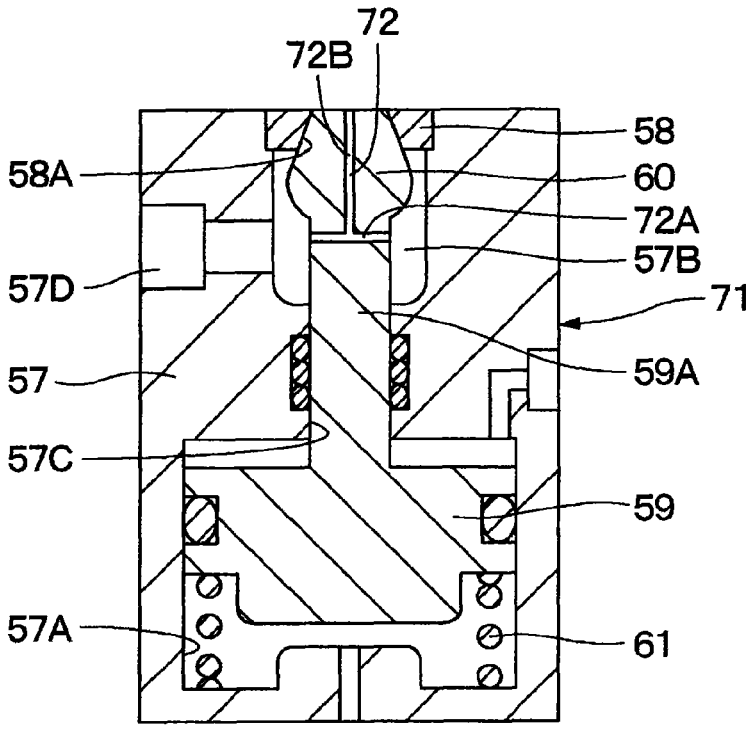
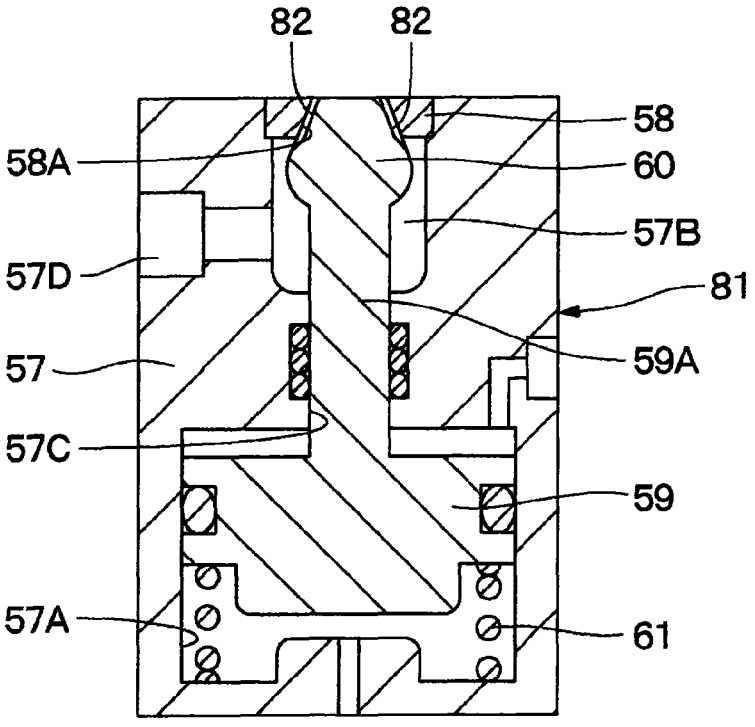

72
72B
58
58A
60
72A
57B
57D
71
57
59A
57C
59
57A
61

Fig. 11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82
58
58A
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57B
57D
81
57
59A
57C
59
57A
61

Fig. 12

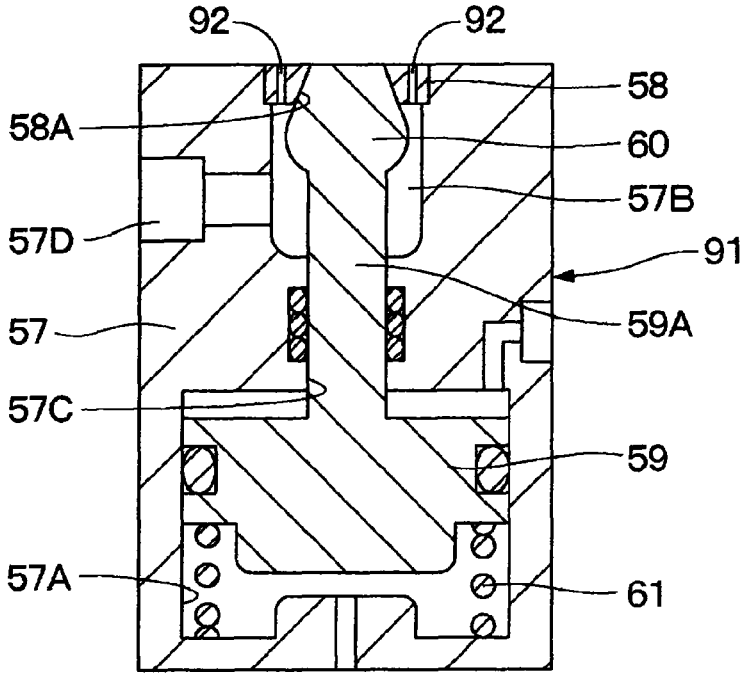

92
92
58
58A
60
57B
57D
91
57
59A
57C
59
57A
61

Fig. 13

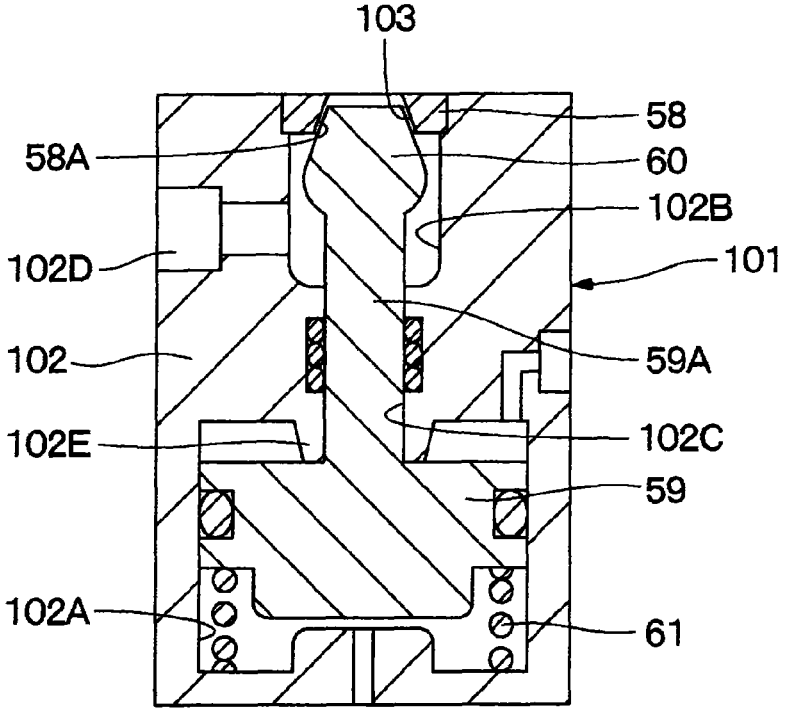

103
58
58A
60
102B
102D
101
102
59A
102E
102C
59
102A
61

Fig. 14

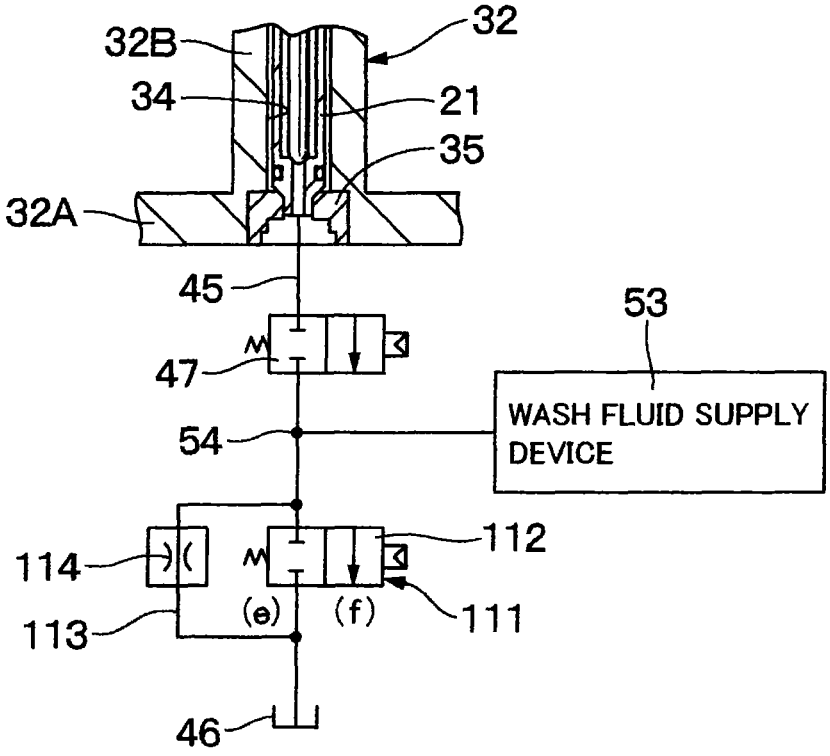

32
32B
34
21
35
32A
45
53
47
WASH FLUID SUPPLY DEVICE
54
112
114
(e)
(f)
111
113
46

Fig.15

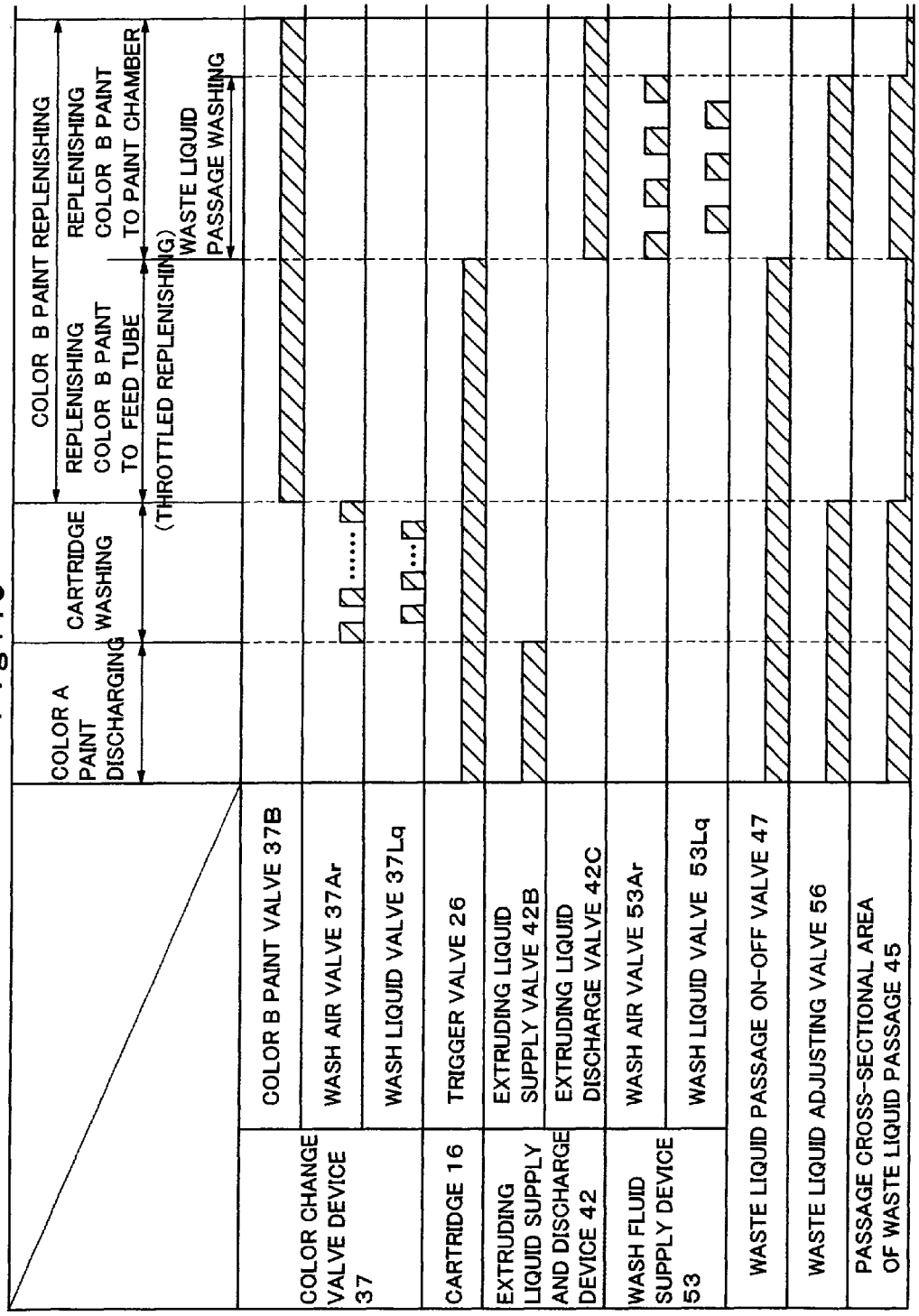
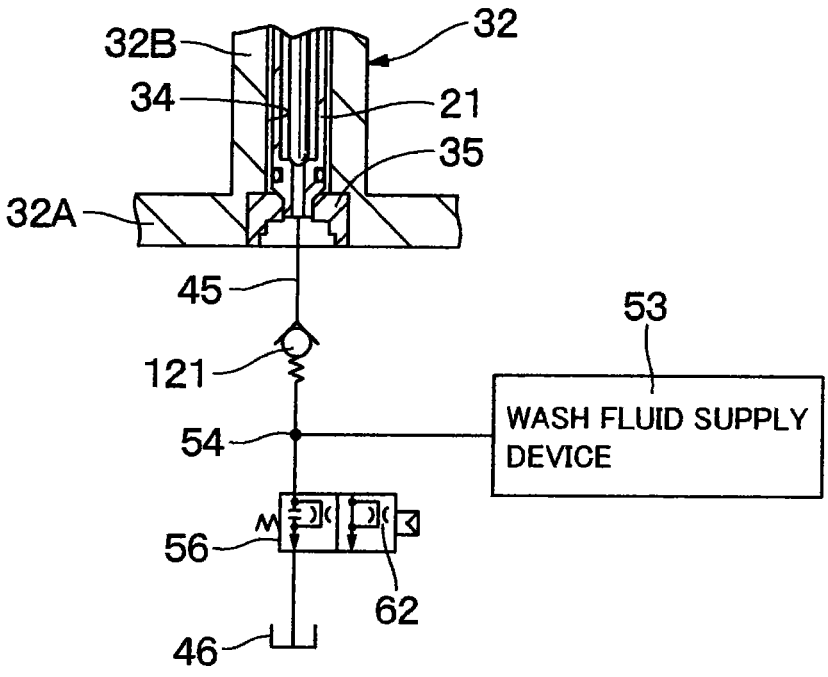

COLOR A PAINT DISCHARGING
CARTRIDGE WASHING
COLOR B PAINT REPLENISHING
REPLENISHING COLOR B PAINT TO FEED TUBE
(THROTTLED REPLENISHING)
REPLENISHING COLOR B PAINT TO PAINT CHAMBER
WASTE LIQUID PASSAGE WASHING
COLOR CHANGE VALVE DEVICE 37
COLOR B PAINT VALVE 37B
WASH AIR VALVE 37Ar
WASH LIQUID VALVE 37Lq
CARTRIDGE 16
TRIGGER VALVE 26
EXTRUDING LIQUID SUPPLY AND DISCHARGE DEVICE 42
EXTRUDING LIQUID SUPPLY VALVE 42B
EXTRUDING LIQUID DISCHARGE VALVE 42C
WASH FLUID SUPPLY DEVICE 53
WASH AIR VALVE 53Ar
WASH LIQUID VALVE 53Lq
WASTE LIQUID PASSAGE ON-OFF VALVE 47
WASTE LIQUID ADJUSTING VALVE 56
PASSAGE CROSS-SECTIONAL AREA OF WASTE LIQUID PASSAGE 45

Fig. 16


32B
32
34
21
35
32A
45
53
121
WASH FLUID SUPPLY DEVICE
54
56
62
46

PAINT REPLENISHING APPARATUS FOR CARTRIDGE AND PAINT REPLENISHING METHOD THEREOF

TECHNICAL FIELD

This invention relates to a paint replenishing apparatus **1** for a cartridge and a paint replenishing method thereof suitable for, for example, replenishing paint into a cartridge which is replaceably mounted on a coating apparatus.

BACKGROUND ART

Generally, a coating apparatus for coating a work piece such as the body of an automobile is required to be able to reduce the amount of paint discarded at the time of color change and to be able to deal with numerous coating colors. As a coating apparatus for dealing with these requirements, a cartridge type coating apparatus is known which is arranged such that a cartridge with paint replenished therein is replaceably mounted on a paint spraying apparatus or a coating apparatus.

The cartridge which is used in the cartridge type coating apparatus is constituted by a tank into which paint is replenished, a feed tube whose proximal end side is mounted on the tank and whose fore distal end side extends in an axial direction from the tank, a partition wall which is provided movably in the tank and partitions an interior of the tank into a paint chamber and an extruding liquid chamber, and a paint valve for opening and closing a paint supply passage in the feed tube at a fore distal end portion of the feed tube. The cartridge allows paints of a plurality of colors to be used by effecting a color change, and is arranged such that its interior is washed clean on every occasion of the color change, and a next color paint is replenished into it.

The paint replenishing apparatus for a cartridge for replenishing paint into a cartridge is largely constituted by a cartridge support member in which a feed tube insertion hole for insertion of the feed tube therethrough is provided in such a manner as to extend in the axial direction, and in which a tank support portion for supporting the tank of the cartridge at the time of the replenishment of paint is provided on a side of an insertion port of the feed tube insertion hole; a color change valve device which is provided by being connected to the cartridge support member, and which supplies a paint selected from among paints of a plurality of colors into the paint chamber of the cartridge and the paint supply passage of the feed tube at the time of the replenishment of paint, and supplies a wash fluid into the paint supply passage of the feed tube through the paint chamber at the time of washing off of remaining paint; an extruding liquid supply and discharge device which is provided by being connected to the cartridge support member, and which supplies the extruding liquid toward the extruding liquid chamber of the cartridge at the time of the washing and discharges the extruding liquid from the extruding liquid chamber at the time of the replenishment of paint; a waste liquid passage having one end side provided in communication with the feed tube insertion hole by being located on a bottom side of the feed tube insertion hole of the cartridge support member and another end side communicating with a waste liquid tank; a waste liquid passage on-off valve which is provided in the waste liquid passage to open and close the waste liquid passage; and a wash fluid supply device which is provided by being connected to the waste liquid passage and located on an outlet side of the waste liquid passage on-off valve and supplies a wash fluid for washing clean the waste liquid passage.

In the replenishment operation of replenishing paint into the cartridge by the paint replenishing apparatus for a cartridge, a used cartridge is mounted on the tank support portion of the cartridge support member, and a previous color paint remaining in the paint chamber of the cartridge is discharged to the side of the waste liquid passage connected to the discharge side of the feed tube. Next, a wash fluid is supplied from the color change valve device to wash off the previous color paint attached to the paint chamber of the cartridge and paint supply passage of the feed tube. Subsequently, a next color paint is supplied from the color change valve device, and is replenished into the paint chamber of the cartridge and the paint supply passage of the feed tube (for example, see Patent Document 1 and Patent Document 2).

PRIOR ART DOCUMENTS

Patent Documents

Patent Document 1: Japanese Patent Laid-Open No. 2000-176328 A

Patent Document 2: Japanese Patent Laid-Open No. 2006-341198 A

SUMMARY OF THE INVENTION

In the replenishment operation of replenishing paint into the cartridge, the paint needs to be reliably replenished up to the fore end of the feed tube so that the paint can be sprayed simultaneously with the start of the coating operation using the next color.

In this instance, the paint which is replenished into the paint chamber of the cartridge and the paint supply passage of the feed tube is a viscous fluid and therefore has the characteristic that the higher the temperature, the lower the viscosity, and the lower the temperature, the higher the viscosity. In an actual coating line, the temperature of paint undesirably changes easily by being affected by the operating conditions of various equipment, and fluctuations in the ambient temperature due to the atmospheric temperature and the like.

On the other hand, when paint flows through a conduit, pressure loss occurs in the conduit, and this pressure loss becomes large with an increase in the viscosity of the paint. For this reason, even if the supply pressure of paint at an inlet portion of the conduit is the same, the discharge rate of paint at an outlet portion (discharge port) of the conduit becomes greater in the case of paint with a low viscosity than paint with a high viscosity. Moreover, the pressure loss within the conduit changes depending on the cross-sectional area and the length dimension of the conduit.

Accordingly, the paint which is supplied from the paint supply source to paint valves of the color change valve device undergoes a change in its viscosity in correspondence with the fluctuation of the ambient temperature in and around the coating facility during the operation of the coating line. Hence, the discharge rate of the paint from the outlet portion of the conduit, namely, the fore end of the feed tube, also increases or decreases in correspondence with the change in viscosity of the paint.

For this reason, the pressure of supplying paint for each color is constantly set at a predetermined pressure so that the paint can be replenished up to the fore end of the feed tube in a predetermined paint replenishing time even under the state of a highest viscosity. However, even if the paint is replenished into the paint supply passage of the feed tube for a predetermined replenishing time under the predetermined supply pressure set for each color paint, when the viscosity of

the paint has become low, the discharge rate of the paint from the fore end of the feed tube becomes large. As a result, there is a problem in that since a large amount of paint is discharged from the feed tube when the viscosity of the paint has become low in the case of replenishing paint into the cartridge, a large amount of paint is disadvantageously discarded wastefully from the time the trigger valve is opened until it is closed.

In view of the above-discussed problems with the conventional art, it is an object of the present invention to provide a paint replenishing apparatus for a cartridge and a paint replenishing method thereof which make it possible to reduce the amount of paint which is discharged from the feed tube and is discarded when paint is replenished into the cartridge.

(1) A paint replenishing apparatus for a cartridge according to the present invention comprises a cartridge for storing paint to be supplied to a coating apparatus, constituted by a tank, a feed tube whose proximal end side is mounted on the tank and whose fore distal end side extends in an axial direction from the tank, a partition wall which is provided movably in the tank and partitions an interior of the tank into a paint chamber into which paint is replenished and an extruding liquid chamber to and from which an extruding liquid is supplied and discharged, and a trigger valve for opening and closing a paint supply passage in the feed tube at a fore distal end portion of the feed tube; a cartridge support member in which a feed tube insertion hole for insertion of the feed tube therethrough is provided in such a manner as to extend in the axial direction, and in which a tank support portion for supporting the tank of the cartridge is provided on a side of an insertion port of the feed tube insertion hole; a color change valve device which is provided by being connected to the cartridge support member, and which supplies a paint selected from among paints of a plurality of colors into the paint chamber of the cartridge and the paint supply passage of the feed tube at a time of replenishment of paint, and supplies a wash fluid into the paint supply passage of the feed tube through the paint chamber at a time of washing off of remaining paint; an extruding liquid supply and discharge device which is provided by being connected to the cartridge support member, and which supplies the extruding liquid toward the extruding liquid chamber of the cartridge at the time of the washing and discharges the extruding liquid from the extruding liquid chamber at the time of the replenishment of paint; a waste liquid passage having one end side provided in communication with the feed tube insertion hole by being located on a bottom side of the feed tube insertion hole of the cartridge support member and another end side communicating with a waste liquid tank; a waste liquid passage on-off valve which is provided in the waste liquid passage to open and close the waste liquid passage; and a wash fluid supply device which is provided by being connected to the waste liquid passage and located on an outlet side of the waste liquid passage on-off valve and supplies a wash fluid for washing clean the waste liquid passage.

To overcome the above-described problems, the characteristic of the configuration adopted in the present invention lies in that a waste liquid adjusting valve is provided in the waste liquid passage by being located on a downstream side of the waste liquid passage on-off valve, and the waste liquid adjusting valve is arranged to widely enlarge a passage cross-sectional area of the waste liquid passage at the time of washing clean the paint chamber and the paint supply passage of the feed tube, and is arranged to narrowly throttle the passage cross-sectional area of the waste liquid passage at the time of replenishing paint into the paint supply passage of the feed tube.

With this arrangement, when washing clean the paint chamber of the cartridge and the paint supply passage of the feed tube, the waste liquid adjusting valve is opened to enlarge the passage cross-sectional area of the waste liquid passage, thereby making it possible to allow the wash fluid to be actively flowed through the waste liquid passage, so that the previous color paint remaining in the paint chamber and the paint supply passage can be effectively washed away in a short time.

Meanwhile, when a next color paint is replenished into the paint supply passage of the feed tube, the arrival time when the paint reaches the discharge port of the feed tube is set as the paint replenishing time for the feed tube in correspondence with a minimum discharge rate of the paint (a discharge rate of paint estimated to be minimal on the basis of various conditions) which is based on such conditions as the viscosity of paint to be replenished and the length dimension and inside diameter dimension (pressure loss) of the supply passage.

Accordingly, the waste liquid adjusting valve is throttled such that the passage cross-sectional area of the waste liquid passage becomes small over the entire duration of the paint replenishing time for the feed tube or prior to completion of the replenishing of paint into the paint supply passage of the feed tube. Consequently, since the passage cross-sectional area of the waste liquid passage becomes small, the amount of paint discharged from the discharge port of the feed tube is reduced.

As a result, when paint is replenished into the paint supply passage of the feed tube, even in cases where the paint replenishing time varies due to various conditions, the waste liquid adjusting valve narrowly throttles the passage cross-sectional area of the waste liquid passage, so that it is possible to reduce the amount of paint which would otherwise be discharged wastefully from the discharge port of the feed tube, thereby making it possible to decrease the amount of paint discarded when the next color paint is replenished.

(2) In this instance, according to the apparatus of the present invention, at the time of replenishing a next color paint into the paint supply passage of the feed tube, the waste liquid adjusting valve may be arranged to be opened in a state in which the passage cross-sectional area of the waste liquid passage is widely enlarged in advance, and may be arranged to narrowly throttle the passage cross-sectional area of the waste liquid passage prior to completion of replenishing.

With this arrangement, in the state in which the waste liquid adjusting valve is opened to enlarge the passage cross-sectional area, paint can be speedily replenished into the paint supply passage of the feed tube, thereby making it possible to shorten the replenishing time. Meanwhile, as the waste liquid adjusting valve decreases the passage cross-sectional area of the waste liquid passage prior to completion of replenishing, it is possible to reduce the discharge rate of paint which is discarded from the discharge port of the feed tube.

(3) In this instance, according to the apparatus of the present invention, at the time of replenishing a next color paint into the paint supply passage of the feed tube, the waste liquid adjusting valve may be arranged to narrowly throttle the passage cross-sectional area of the waste liquid passage continuously from a start to an end of replenishing.

With this arrangement, in the operation of replenishing paint into the paint supply passage of the feed tube, the passage cross-sectional area of the waste liquid passage can be constantly made small, and therefore it is possible to reduce the discharge rate of paint which is discarded from the discharge port of the feed tube.

(4) According to the apparatus of the present invention, the waste liquid adjusting valve is constituted by a valve casing

having a valve seat in the course of the waste liquid passage and a valve body which is seated on and unseated from the valve seat, and the waste liquid adjusting valve is arranged to be provided with a throttle passage for allowing paint to be flowed therethrough with a small passage cross-sectional area in a closing position in which the valve body abuts against the valve seat.

With this arrangement, the waste liquid adjusting valve is able to control the valve body between two positions, namely, the opening position and the closing position, so that the mechanism can be simplified. Moreover, when the waste liquid adjusting valve is closed, the passage cross-sectional area of the waste liquid passage can be throttled by the throttle passage so as to become fixed irrespective of various conditions of the paint.

(5) According to the apparatus of the present invention, the waste liquid adjusting valve is constituted by a valve casing having a valve seat in the course of the waste liquid passage and a valve body which is seated on and unseated from the valve seat, and the valve casing is provided with a stopper for holding the valve body in a proximate position which is proximate to the valve seat to form a throttle passage between the valve seat and the valve body so as to allow the paint to flow with a small passage cross-sectional area.

With this configuration, the waste liquid adjusting valve is able to control the valve body between two positions, namely, the opening position and the proximate position, so that the mechanism can be simplified. Moreover, when the waste liquid adjusting valve is disposed in the proximate position, the passage cross-sectional area of the waste liquid passage can be throttled by the throttle passage so as to become fixed irrespective of various conditions of the paint.

(6) A paint replenishing method for a cartridge in accordance with the present invention is a paint replenishing method for a cartridge for replenishing paint to be supplied to a coating apparatus into a cartridge which is constituted by a tank into which the paint is replenished, a feed tube whose proximal end side is mounted on the tank and whose fore distal end side extends in an axial direction from the tank, a partition wall which is provided movably in the tank and partitions an interior of the tank into a paint chamber and an extruding liquid chamber, and a trigger valve for opening and closing a paint supply passage in the feed tube at a fore distal end portion of the feed tube, the paint replenishing method for a cartridge further comprising: a previous color paint discharging step of discharging a previous color paint remaining in the paint chamber of the cartridge to a side of a waste liquid passage connected to a discharge side of the feed tube; a cartridge washing step of washing off the previous color paint attached to the paint chamber of the cartridge and the paint supply passage of the feed tube; a feed tube side paint replenishing step of replenishing a next color paint in a state in which a discharge rate of the paint from the paint supply passage is decreased by narrowly regulating a passage cross-sectional area of the waste liquid passage when the next color paint is replenished into the paint supply passage of the feed tube; and a paint chamber side paint replenishing step of replenishing the next color paint into the paint chamber of the cartridge in a state in which the waste liquid passage is closed upon completion of replenishing of the next color paint into the paint supply passage of the feed tube.

With this arrangement, when paint is replenished into the cartridge, the previous color paint remaining in the paint chamber of the cartridge is discharged to the side of the waste liquid passage connected to the discharge side of the feed tube by the previous color paint discharging step and the cartridge washing step, and the previous paint attached to the paint chamber of the cartridge and the paint supply passage of the feed tube is washed off. Next, when the next color paint is replenished into the paint supply passage of the feed tube by the feed tube side paint replenishing step, the next color paint is replenished in a state in which the discharge rate of the paint from the paint supply passage is decreased by narrowly regulating the passage cross-sectional area of the waste liquid passage. After completion of this replenishing of the next color paint into the paint supply passage of the feed tube, next color paint is replenished into the paint chamber of the cartridge with the waste liquid passage closed by the paint chamber side paint replenishing step. Hence, it is possible to reduce the paint which is wastefully discharged from the discharge port of the feed tube.

(7) According to the method of the present invention, in the feed tube side paint replenishing step, the next color paint may be arranged to be replenished in a state in which the discharge rate of the paint from the paint supply passage is increased by widely regulating the passage cross-sectional area of the waste liquid passage in advance, and prior to completion of replenishing the discharge rate of the paint from the paint supply passage is decreased by narrowly regulating the passage cross-sectional area of the waste liquid passage.

With this arrangement, it is possible to reduce the replenishing time in the feed tube side paint replenishing step. Meanwhile, as the discharge rate of the paint from the paint supply passage is decreased prior to completion of replenishing by narrowly regulating the passage cross-sectional area of the waste liquid passage, it is possible to reduce the discharge rate of paint which is discarded from the discharge port of the feed tube.

(8) According to the method of the present invention, in the feed tube side paint replenishing step, the passage cross-sectional area of the waste liquid passage may be arranged to be narrowly throttled through an entire step of replenishing paint into the paint supply passage of the feed tube.

With this arrangement, in the feed tube side paint replenishing step, the passage cross-sectional area of the waste liquid passage can be constantly made small, and therefore it is possible to reliably reduce the discharge rate of paint which is discarded from the discharge port of the feed tube.

(9) According to the method of the present invention, the method further comprises a waste liquid passage washing step of washing clean the waste liquid passage while the paint chamber side paint replenishing step is being executed. According to this configuration, the paint chamber side paint replenishing step and the waste liquid passage washing step can be executed in parallel, thereby making it possible to improve the operational efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view showing general arrangement of a paint replenishing apparatus for a cartridge in accordance with a first embodiment of the present invention illustrating together with a coating robot and the like.

FIG. **2** is a longitudinal cross-sectional view illustrating in enlarged form a rotary atomizing head type coating apparatus shown in FIG. **1**.

FIG. **3** is a longitudinal cross-sectional view illustrating a cartridge, shown in FIG. **2**, as a single unit.

FIG. **4** is a circuit diagram illustrating the paint replenishing apparatus for a cartridge in accordance with a first embodiment.

FIG. **5** is a longitudinal cross-sectional view illustrating in enlarged form a cartridge support member shown in FIG. **4**.

FIG. **6** is a longitudinal cross-sectional view illustrating a waste liquid passage on-off valve and a waste liquid adjusting valve, shown in FIG. **4**, both in a closed state.

FIG. **7** is a transverse cross-sectional view taken from the direction of arrows VII-VII in FIG. **6**.

FIG. **8** is a longitudinal cross-sectional view illustrating the waste liquid passage on-off valve and the waste liquid adjusting valve, shown in FIG. **6**, both in an opened state.

FIG. **9** is a time chart illustrating a paint replenishing method for replenishing paint by the paint replenishing apparatus for a cartridge.

FIG. **10** is a longitudinal cross-sectional view illustrating the waste liquid adjusting valve in accordance with a second embodiment.

FIG. **11** is a longitudinal cross-sectional view illustrating the waste liquid adjusting valve in accordance with a third embodiment.

FIG. **12** is a longitudinal cross-sectional view illustrating the waste liquid adjusting valve in accordance with a fourth embodiment.

FIG. **13** is a longitudinal cross-sectional view illustrating the waste liquid adjusting valve in accordance with a fifth embodiment.

FIG. **14** is a longitudinal cross-sectional view illustrating the waste liquid adjusting valve in accordance with a sixth embodiment.

FIG. **15** is a time chart illustrating the paint replenishing method for a cartridge in accordance with a seventh embodiment.

FIG. **16** is a circuit diagram illustrating the waste liquid passage on-off valve in accordance with a modification.

MODE FOR CARRYING OUT THE INVENTION

Hereafter, a paint replenishing apparatus for a cartridge and a paint replenishing method thereof in the embodiments of the present invention will be in detail explained with reference to the accompanying drawings by taking a case in which paint is replenished into a cartridge which is replaceably mounted on a rotary atomizing head type coating apparatus as an example.

FIGS. **1** to **9** show a paint replenishing apparatus for a cartridge and a paint replenishing method thereof in accordance with a first embodiment of the present invention.

In FIG. **1**, indicated at **201** is a robot traveling rail, and the rail **201** is provided along a below-described vehicle body transport line **203**. A coating robot **202** is largely constituted by a pedestal **202**A which is movable on the robot traveling rail **201**, a vertical arm **202**B which is rotatably and swingably provided on the pedestal **202**A, a horizontal arm **202**C which is swingably provided at a fore distal end of the vertical arm **202**B, and a wrist **202**D provided at a fore distal end of the horizontal arm **202**C. The vehicle body transport line **203** is disposed in a coating plant, and by the vehicle body transport line **203**, a vehicle body **204** of an automobile, which is a work piece, passes the front side of the coating robot **202**.

Indicated at **205** is a cartridge transfer device which is arranged in the vicinity of the coating robot **202**. This cartridge transfer device **205** is constituted by an articulated (multi-axis) robot or an exclusive transfer device, and is adapted to hold a cartridge **16** and transfer it between a rotary atomizing head type coating apparatus **1** and a paint replenishing apparatus for a cartridge **31**, which will be described hereinafter.

Next, the rotary atomizing head type coating apparatus **1** to which the first embodiment of the present invention is applied will be explained.

Designated at **1** is the rotary atomizing head type coating apparatus (hereafter referred to as the coating apparatus **1**) which is provided on the wrist **202**D of the coating robot **202**. As shown in FIG. **2**, this coating apparatus **1** is largely constituted by a housing **2**, a coater unit **6**, the cartridge **16**, and the like which will be described hereinafter.

Indicated at **2** is the housing which is mounted at a fore distal end of the wrist **202**D of the coating robot **202**. This housing **2** is constituted by a neck portion **3** which is detachably mounted at the fore distal end of the wrist **202**D of the coating robot **202** and a head portion **4** which is integrally formed on a fore distal end of the neck portion **3**.

Here, a coater unit mounting portion **4**A is formed on a front side of the head portion **4** in a recessed cylindrical shape, while a cartridge mounting portion **4**B is formed on a rear side of the head portion **4** in a recessed cylindrical shape. A fitting hole **4**C, to which a quick joint **23** of the below-described cartridge **16** is fitted, and a female connecting portion **4**D, to which a quick joint **25** is connected, are formed in a bottom portion of the cartridge mounting portion **4**B. The fitting hole **4**C and the female connecting portion **4**D also function to position a tank **17** of the cartridge **16** in a circumferential direction at the time of mounting the tank **17** to the cartridge mounting portion **4**B.

Indicated at **5** is a feed tube insertion hole which is provided in a central portion of the head portion **4** in such a manner as to extend in an axial direction. This feed tube insertion hole **5** is for allowing a feed tube **21** of the below-described cartridge **16** to be inserted therein. The feed tube insertion hole **5** is formed in the axial direction in such a manner as to extend through the coater unit mounting portion **4**A of the head portion **4** and penetrate the interior of a rotational shaft **8** of a below-described air motor **7**.

Designated at **6** is the coater unit which is mounted on the coater unit mounting portion **4**A of the head portion **4**. The coater unit **6** is constituted by an air motor **7** comprising a motor case **7**A, an air turbine **7**B, and an air bearing **7**C; the rotational shaft **8** supported rotatably by the air bearing **7**C in a state in which the air turbine **7**B is mounted on its proximal end portion; a rotary atomizing head **9** which is mounted at a fore distal end of the rotational shaft **8** and is adapted to centrifugally atomize supplied paint by being rotated by the air motor **7** so as to spray the atomized paint toward the work piece; and a shaping air ring **10** provided on the front end side of the air motor **7**. This shaping air ring **10** is adapted to spurt out shaping air toward a releasing edge of the rotary atomizing head **9** so as to effect the pattern shaping of paint particles released from the rotary atomizing head **9**.

A high voltage generator **11** is provided in the neck portion **3** of the housing **2**. This high voltage generator **11** is constituted by, for example, a Cockcroft circuit and is adapted to boost a voltage supplied from a power supply device (not shown) from −60 to −120 kV. The output side of the high voltage generator **11** is electrically connected to, for example, the air motor **7**, whereby the high voltage generator **11** applies a high voltage to the rotary atomizing head **9** through the rotational shaft **8** so as to allow the paint which is supplied to the rotary atomizing head **9** to be directly charged electrostatically.

A plurality of air passages **12** and **13** are provided in the neck portion **3** of the housing **2** and are connected to a control air source (not shown). These air passages **12** and **13** are for supplying such as turbine air for controlling the air motor **7**, bearing air, brake air, shaping air for forming the spray pattern of paint, and pressurized air for the opening and closing operation of valve bodies of an extruding liquid valve **15** and

a trigger valve **26**. In the first embodiment, however, only two air passages **12** and **13** are typically illustrated.

A housing side extruding liquid passage **14** is provided in the housing **2**. This extruding liquid passage **14** has one end connected to a extruding liquid supplying device (not shown) and the other end open to a bottom portion of the female connecting portion **4**D of the cartridge mounting portion **4**B formed in the head portion **4**.

Furthermore, the extruding liquid valve **15** is provided in the head portion **4** of the housing **2**. This extruding liquid valve **15** is normally in a closed state to shut off between the extruding liquid passage **14** and an extruding liquid chamber **20** of the cartridge **16**. On the other hand, the extruding liquid valve **15**, when opened, allows the circulation of an extruding liquid to and from the extruding liquid chamber **20** to thereby effect the supply and discharge of the extruding liquid.

Next, the configuration of the cartridge **16** which is used in the first embodiment of the present invention will be explained.

Designated at **16** is the cartridge which is detachably mounted on the cartridge mounting portion **4**B of the head portion **4**, and the cartridge **16** is mounted on and dismounted from a cartridge support member **32** of the below-described paint replenishing apparatus for a cartridge **31**. As shown in FIG. **3**, the cartridge **16** is constituted by such as the tank **17**, a piston **18**, and the feed tube **21** which will be described hereinafter.

The tank **17** of the cartridge **16** is formed as a cylindrical container with both axial ends blocked. The piston **18** which forms a movable partition wall is insertingly fitted in this tank **17** so as to be axially displaceable, and the piston **18** partitions the interior of the tank **17** into a front side paint chamber **19** and the rear side extruding liquid chamber **20**.

An extruding liquid passage **24** is formed on the rear side of the tank **17** in such a manner as to be open to the extruding liquid chamber **20**, and a grip projection **17**A for gripping the cartridge **16** is provided at a rear end portion of the tank **17**. Meanwhile, a paint passage **17**B for allowing a paint supply passage **21**A of the below-described feed tube **21** to communicate with the paint chamber **19** is provided on the front side of the tank **17**. Further, a joint mounting hole **17**C for mounting the below-described quick joint **23** and a joint mounting hole **17**D for mounting a quick joint **25** are provided on the front side of the tank **17**.

The feed tube **21** is provided at a central position on the front side of the tank **17** in such a manner as to extend in the axial direction. The distal end side of this feed tube **21** extends through the feed tube insertion hole **5**, and its fore distal end portion is open toward the rotary atomizing head **9**. The paint supply passage **21**A communicating with the paint chamber **19** of the tank **17** through the paint passage **17**B is formed in the feed tube **21**. Further, a valve seat portion **21**B formed by reducing the diameter of the aforementioned paint supply passage **21**A is provided on the distal end side of the feed tube **21**.

A cartridge side paint passage **22** is provided on the front side of the tank **17** in such a manner as to communicate with a front portion of the paint chamber **19**. As shown in FIGS. **4** and **5**, this cartridge side paint passage **22** is provided radially outwardly of the feed tube **21** and communicates with the front portion of the paint chamber **19**. Meanwhile, when the cartridge **16** is mounted on the below-described cartridge support member **32**, the cartridge side paint passage **22** is able to communicate with a paint line **36** on the cartridge support member **32** side.

The quick joint **23** with a check valve is provided in the joint mounting hole **17**C of the tank **17** by being located at an open end of the cartridge side paint passage **22**. When the tank **17** is mounted on a tank support portion **33** of the cartridge support member **32**, this quick joint **23** opens its valve to allow the circulation of paint, and when the tank **17** is removed from the tank support portion **33**, the quick joint **23** closes its valve to prevent the paint from flowing out from the cartridge side paint passage **22**.

The cartridge side extruding liquid passage **24** is provided in a peripheral wall of the tank **17** in such a manner as to communicate with the extruding liquid chamber **20**. As shown in FIG. **2**, when the tank **17** of the cartridge **16** is insertingly fitted in the cartridge mounting portion **4**B of the head portion **4**, this extruding liquid passage **24** communicates with the housing side extruding liquid passage **14**. Meanwhile, as shown in FIG. **5**, when the tank **17** of the cartridge **16** is insertingly fitted in the tank support portion **33** of the cartridge support member **32**, the extruding liquid passage **24** communicates with an extruding liquid line **41**.

The quick joint **25** with a check valve is provided in the joint mounting hole **17**D of the tank **17** by being located at an open end of the cartridge side extruding liquid passage **24**. This quick joint **15** functions substantially in the same way as the aforementioned quick joint **23**, and when the tank **17** is mounted on the cartridge mounting portion **4**B of the head portion **4** or the tank support portion **33** of the cartridge support member **32**, this quick joint **25** opens its valve to allow the circulation of the extruding liquid, and when the tank **17** is removed from the cartridge mounting portion **4**B or the tank support portion **33**, the quick joint **25** closes its valve to prevent the extruding liquid from flowing out from the cartridge side extruding liquid passage **24**.

Further, the trigger valve **26** is provided on a front side portion of the tank **17**. This trigger valve **26** supplies or stops supplying the paint from the feed tube **21** toward the rotary atomizing head **9**. Here, this trigger valve **26** is a two-way and two-position normally closed air-driven type on-off valve which is largely constituted by an axially displaceable piston **26**A and a valve body **26**B whose valve stem extends from the piston **26**A through the paint supply passage **21**A of the feed tube **21** and whose distal end is seated on and unseated from the valve seat portion **21**B.

Next, the paint replenishing apparatus for a cartridge **31** which is used in the first embodiment will be explained.

Designated at **31** is the paint replenishing apparatus for a cartridge in accordance with the first embodiment which is provided in the vicinity of the operational range of the coating robot **202** (see FIG. **1**). This paint replenishing apparatus for a cartridge **31** is for washing clean the used cartridge **16** which was used in coating and for replenishing paint of a next color. Here, the paint replenishing apparatus for a cartridge **31** is largely constituted by the cartridge support member **32**, a color change valve device **37**, an extruding liquid supply and discharge device **42**, a waste liquid passage **45**, a waste liquid passage on-off valve **47**, a wash fluid supply device **53**, and a waste liquid adjusting valve **56**.

Designated at **32** is the cartridge support member of the paint replenishing apparatus for a cartridge **31**. This cartridge support member **32** is constituted by a pedestal portion **32**A, a column portion **32**B extending vertically upward from the pedestal portion **32**A, and a seat portion **32**C which is provided by widening the upper side of the column portion **32**B.

The tank support portion **33** is formed on the upper side of the seat portion **32**C. This tank support portion **33** is for mounting the tank **17** of the cartridge **16** thereon. Formed separately on the bottom portion of the tank support portion **33** are a female coupling portion **33**A to which the quick joint

23 of the cartridge 16 is coupled and a female coupling portion 33B to which the quick joint 25 is coupled.

Indicated at 34 is a feed tube insertion hole which is provided in such a manner as to extend vertically through a central portion of the cartridge support member 32. This feed tube insertion hole 34 is for the feed tube 21 of the cartridge 16 to be inserted therethrough when the tank 17 of the cartridge 16 is mounted to the tank support portion 33. For this reason, an upper end of the feed tube insertion hole 34 serves as an insertion port for the feed tube 21.

A feed tube abutting member 35 is provided at a lower end (bottom side) of the feed tube insertion hole 34. This feed tube abutting member 35 is formed as a cylindrical body mounted in the center of the pedestal portion 32A of the cartridge support member 32. The feed tube abutting member 35 is adapted to connect the paint supply passage 21A of the feed tube 21 and the below-described waste liquid passage 45 as the fore distal end of the feed tube 21 air-tightly abuts against its inner peripheral side.

The paint line 36 is provided by being coupled to the seat portion 32C of the cartridge support member 32. As for this paint line 36, its one end side which is an upstream side communicates with a paint discharge port of the below-described color change valve device 37, and its other end side communicates with the female coupling portion 33A of the tank support portion 33.

Indicated at 37 is the color change valve device which is provided by being coupled to the cartridge support member 32 through the paint line 36. At the time of replenishing of paint, a paint to be replenished into the cartridge 16 is selected from among paints of a plurality of colors, and the color change valve device 37 is used to supply the selected paint into the paint chamber 19 of the cartridge 16 and into the paint supply passage 21A of the feed tube 21 through the paint line 36. At the time of washing off the paint remaining in the paint chamber 19 and the paint supply passage 21A, this color change valve device 37 supplies a wash liquid and wash air, which serve as wash fluids, into the paint chamber 19 and the paint supply passage 21A of the feed tube 21.

The color change valve device 37 is a device for controlling selective supply of paint and the wash fluids to the cartridge 16. This color change valve device 37 is constituted by paint valves 37A, 37B, . . . , and 37N for colors A, B, . . . , and N incorporated in a valve casing 38, a wash air valve 37Ar, and a wash liquid valve 37Lq. The paint valves 37A, 37B, . . . , and 37N for colors A, B, . . . , and N are respectively connected to a paint supply source 39 for supplying paints of the colors A, B, . . . , and N, and are connected to the paint line 36. The paint valves 37A, 37B, . . . , and 37N are opened at the time of replenishing the cartridge 16 with paint to supply the respective paint of the colors A, B, . . . , and N from the paint supply source 39.

The wash air valve 37Ar is connected to a wash air source 40Ar and the paint line 36, and the wash liquid valve 37Lq is connected to a wash liquid source 40Lq and the paint line 36. At the time of washing the cartridge 16, the wash air valve 37Ar and the wash liquid valve 37Lq are alternately opened and closed to supply the wash air and the wash liquid.

Here, two-way and two-position air-driven type on-off valves are adopted as the valves 37A, 37B through 37N, 37Ar, and 37Lq in substantially the same way as the below-described waste liquid passage on-off valve 47, and are configured to be normally closed and are opened upon supply of pressurized air thereto.

Meanwhile, the extruding liquid line 41 is provided by being coupled to the seat portion 32C of the cartridge support member 32. As for this extruding liquid line 41, its one end side communicates with the below-described extruding liquid supply and discharge device 42, and its other end side communicates with the female coupling portion 33B of the tank support portion 33.

Indicated at 42 is the extruding liquid supply and discharge device which is provided by being coupled to the cartridge support member 32 through the extruding liquid line 41. At the time of washing off a previous color paint used in the previous coating operation, this extruding liquid supply and discharge device 42 supplies an extruding liquid from an extruding liquid supply source 43 toward the extruding liquid chamber 20 of the cartridge 16. Meanwhile, at the time of replenishing the paint chamber 19 with paint, the extruding liquid supply and discharge device 42 discharges the extruding liquid from the extruding liquid chamber 20 toward an extruding liquid discharge line 44.

The extruding liquid supply and discharge device 42 is a device for supplying and discharging the extruding liquid to and from the extruding liquid chamber 20 of the cartridge 16. For this reason, the extruding liquid supply and discharge device 42 is constituted by an extruding liquid supply valve 42B and an extruding liquid discharge valve 42C which are incorporated in a valve casing 42A. The extruding liquid supply valve 42B is connected to both the extruding liquid supply source 43 and the extruding liquid line 41. The extruding liquid supply valve 42B supplies the extruding liquid from the extruding liquid supply source 43 toward the extruding liquid chamber 20. On the other hand, the extruding liquid discharge valve 42C is connected to both the extruding liquid discharge line 44 and the extruding liquid line 41. When paint is replenished into the paint chamber 19, the extruding liquid discharge valve 42C is opened to allow the extruding liquid in the extruding liquid chamber 20 to flow out to the extruding liquid discharge line 44.

Here, two-way and two-position air-driven type on-off valves are adopted as the extruding liquid supply valve 42B and the extruding liquid discharge valve 42C in substantially the same way as the below-described waste liquid passage on-off valve 47, and are configured to be normally closed and are opened upon supply of pressurized air thereto.

Designated at 45 is the waste liquid passage which is provided by being coupled to a bottom portion side (lower end) of the feed tube insertion hole 34 of the cartridge support member 32. As for the waste liquid passage 45, its inlet port communicates with the paint supply passage 21A of the feed tube 21 in a state in which the fore distal end of the feed tube 21 abuts against the feed tube abutting member 35. Meanwhile, an outlet port of the waste liquid passage 45 communicates with a waste liquid tank 46.

Designated at 47 is the waste liquid passage on-off valve which is provided in the waste liquid passage 45 to open and close the waste liquid passage 45. As shown in FIG. 6, this waste liquid passage on-off valve 47 is constituted by a valve casing 48, a valve seat 49, a piston 50, a valve body 51, a valve spring 52, and the like. The waste liquid passage on-off valve 47 is a two-way and two-position air-driven type on-off valve which is normally closed by pressing the piston 50 by the urging force of the valve spring 52, and is opened against the urging force of the valve spring 52 upon supply of pressurized air to a pressure receiving chamber 48A1 of a piston chamber 48A, as mentioned hereinafter.

The valve casing 48 forms the outer shape of the waste liquid passage on-off valve 47. Namely, this valve casing 48 is formed by the piston chamber 48A, a valve chamber 48B, a valve stem insertion hole 48C allowing the two chambers 48A and 48B to communicate with each other, an inlet port 48D, and the like. The inlet port 48D is connected to the valve

chamber **48**B and communicates with the cartridge support member **32** through the waste liquid passage **45**. Meanwhile, the valve seat **49** forming a part of the valve chamber **48**B is provided in the valve casing **48** at a position opposing the below-described valve body **51**, and the valve chamber **48**B communicates with a connecting point **54** of the waste liquid passage **45** by way of the valve seat **49**. The piston **50** is insertingly fitted slidably in the piston chamber **48**A of the valve casing **48**, and partitions the piston chamber **48**A into the pressure receiving chamber **48**A**1** and a spring chamber **48**A**2**. A valve stem **50**A is provided at an axially central position of the piston **50**, the valve stem **50**A is slidably inserted in the valve stem insertion hole **48**C and extends to the valve chamber **48**B, and the valve body **51** is provided at a fore distal end of the valve stem **50**A.

As the piston **50** is pressed by the valve spring **52** provided in the spring chamber **48**A**2** of the piston chamber **48**A, the valve body **51** is normally closed by being seated on the valve seat **49** to shut off the waste liquid passage **45**. Namely, the waste liquid passage on-off valve **47** is in a closing position (a) in FIG. **4**. Meanwhile, when pressurized air is supplied into the pressure receiving chamber **48**A**1** of the piston chamber **48**A to displace the piston **50** in the opposite direction in opposition to the valve spring **52**, the waste liquid passage on-off valve **47** is able to open the valve body **51** to allow the waste liquid passage **45** to communicate. Namely, the waste liquid passage on-off valve **47** is in an opening position (b) in FIG. **4**.

Indicated at **53** is the wash fluid supply device which is connected to the waste liquid passage **45** by being located on the downstream side of the waste liquid passage on-off valve **47**. This wash fluid supply device **53** is constituted by a wash air valve **53**Ar and a wash liquid valve **53**Lq. The wash fluid supply device **53** is a device for supplying the wash air and the wash liquid to the waste liquid passage **45** so as to wash off the paint adhering to the waste liquid passage **45** at the time of replenishing the cartridge **16** with paint and at the time of discharging the paint remaining in the cartridge **16**. The wash fluid supply device **53** is located in the waste liquid passage **45** between the waste liquid passage on-off valve **47** and the below-described waste liquid adjusting valve **56**, and is connected to the connecting point **54** of the waste liquid passage **45** through the supply line **53**A and to a wash air source **55**Ar and a wash liquid source **55**Lq, respectively.

Namely, the wash air valve **53**Ar is connected to the wash air source **55**Ar and is also connected to the supply line **53**A to supply the wash air from the wash air source **55**Ar to the waste liquid passage **45**. The wash liquid valve **53**Lq is connected to the wash liquid source **55**Lq and is also connected to the supply line **53**A to supply the wash liquid from the wash liquid source **55**Lq to the waste liquid passage **45**. At the time of washing off the waste liquid passage **45**, the wash air valve **53**Ar and the wash liquid valve **53**Lq are alternately opened and closed to wash off the paint remaining in the waste liquid passage **45** by allowing the wash air and the wash liquid to flow out.

Here, two-way and two-position air-driven type on-off valves are adopted as the wash air valve **53**Ar and the wash liquid valve **53**Lq in the same way as the above-described waste liquid passage on-off valve **47**, and are configured to be normally closed and are opened upon supply of pressurized air thereto.

Next, the configuration of the waste liquid adjusting valve **56** used in the first embodiment will be explained.

Designated at **56** is the waste liquid adjusting valve which is provided in the waste liquid passage **45**, and the waste liquid adjusting valve **56** is provided on the downstream side of the waste liquid passage on-off valve **47**, namely, on the downstream side of the connecting point **54** between the waste liquid passage **45** and the wash fluid supply device **53**. As shown in FIG. **8**, at the time of washing clean the paint chamber **19** of the cartridge **16** and the paint supply passage **21**A of the feed tube **21**, this waste liquid adjusting valve **56** is opened to widely enlarge the passage cross-sectional area of the waste liquid passage **45**. Meanwhile, as shown in FIG. **6**, at the time of replenishing the paint supply passage **21**A of the feed tube **21** with paint, the waste liquid adjusting valve **56** is closed prior to completion of replenishing to narrowly throttle the passage cross-sectional area of the waste liquid passage **45**.

The waste liquid adjusting valve **56** is formed as a two-way and two-position air-driven type on-off valve in substantially the same way as the above-described waste liquid passage on-off valve **47**, and is constituted by such as a valve casing **57**, a valve seat **58**, a piston **59**, a valve body **60**, and a valve spring **61** which will be described hereinafter. However, the waste liquid adjusting valve **56** differs from the waste liquid passage on-off valve **47** in that the valve seat **58** is provided with throttle passages **62**.

The valve casing **57** forms the outer shape of the waste liquid adjusting valve **56**. Namely, this valve casing **57** is formed as a hollow casing by a piston chamber **57**A, a valve chamber **57**B, a valve stem insertion hole **57**C allowing the two chambers **57**A and **57**B to communicate with each other, an outlet port **57**D, and the like. The valve casing **57** is provided with the outlet port **57**D at a position corresponding to the valve chamber **57**B, and the outlet port **57**D communicates with the waste liquid tank **46** through the waste liquid passage **45**.

The valve seat **58** is provided by being located at an open end of the valve chamber **57**B opposing the below-described valve body **60** so as to form a part of the valve casing **57**, and the valve seat **58** forms a part of the valve casing **57**. Here, the valve seat **58** is formed as a hollow cylindrical body having a conical inner peripheral surface **58**A opposing the valve body **60**, and the valve body **60** is adapted to be seated on and unseated from the inner peripheral surface **58**A of the valve seat **58**. Further, the below-described throttle passages **62** are provided on the inner peripheral surface **58**A of the valve seat **58** in such a manner as to extend in the axial direction.

The piston **59** is insertingly fitted in the piston chamber **57**A of the valve casing **57** slidably in the axial direction. This piston **59** partitions the piston chamber **57**A into a pressure receiving chamber **57**A**1** and a spring chamber **57**A**2**. Further, a valve stem **59**A is provided at an axially central position of the piston **59**, the valve stem **59**A is slidably inserted in the valve stem insertion hole **57**C and extends to the valve chamber **57**B, and the below-described valve body **60** is provided at a distal end of the valve stem **59**A.

The valve body **60** is provided at the distal end of the valve stem **59**A of the piston **59** by being located in the valve chamber **57**B of the valve casing **57**. This valve body **60** is formed in a conical trapezoidal shape whose diameter becomes smaller toward its distal end, and is adapted to be brought into close contact with the inner peripheral surface **58**A of the valve seat **58**. Here, as the piston **59** is displaced in axial directions, the valve body **60** is unseated from and seated on the inner peripheral surface **58**A of the valve seat **58**.

The valve spring **61** is provided in the spring chamber **57**A**2** of the piston chamber **57**A. This valve spring **61** urges the valve body **60** in the valve closing direction by means of the piston **59**. Hence, the waste liquid adjusting valve **56** is configured as a normally closed valve.

Indicated at **62** are the throttle passages in accordance with the first embodiment which are provided on the valve seat **58**. These throttle passages **62** allow a small amount of paint to flow even in the valve closed state in which the valve body **60** is in close contact with the inner peripheral surface **58**A of the valve seat **58**. Namely, as shown in FIGS. **7** and **8**, the throttle passages **62** are formed as recessed grooves located at a plurality of circumferential positions, for example located at four positions, and formed by axially notching the inner peripheral surface **58**A of the valve seat **58**.

As shown in FIG. **6**, in a state in which pressurized air for driving is stopped, the waste liquid adjusting valve **56** is closed by pressing the valve body **60** against the valve seat **58** by the urging force of the valve spring **61**. Namely, the waste liquid adjusting valve **56** is in a closing position (c) in FIG. **4**. Accordingly, the waste liquid adjusting valve **56** is able to allow a small amount of paint to flow by narrowly regulating the passage cross-sectional area of the waste liquid passage **45** by the throttle passages **62** provided on the valve seat **58**.

Meanwhile, as shown in FIG. **8**, when pressurized air is supplied into the pressure receiving chamber **57**A**1** of the piston chamber **57**A of the valve casing **57** to displace the piston **59** in opposition to the valve spring **61**, the waste liquid adjusting valve **56** is opened by causing the valve body **60** to be unseated from the valve seat **58**. Namely, the waste liquid adjusting valve **56** is in an opening position (d) in FIG. **4**. In consequence, since the waste liquid adjusting valve **56** enlarges the passage cross-sectional area of the waste liquid passage **45**, the waste liquid adjusting valve **56** allows greater amounts of paint and wash fluids to flow than when the waste liquid adjusting valve **56** is closed.

The paint replenishing apparatus for a cartridge **31** in accordance with the first embodiment has the above-described configuration, and a paint replenishing method for the cartridge **16** by the paint replenishing apparatus for a cartridge **31** with reference to a time chart shown in FIG. **9** will be explained in greater details.

It should be noted that the paint replenishing method for a cartridge in accordance with the first embodiment will be explained by citing a case in which a color change is made from a paint of color A as a previous color paint which was used in a previous coating operation to a paint of color B as a next color paint which is used in a next coating operation as an example. Meanwhile, it will be explained under the assumption that the color A paint used in the previous coating operation remains in the paint chamber **19** of the cartridge **16** and the paint supply passage **21**A of the feed tube **21**, respectively.

Upon completion of a coating operation using the color A paint by the rotary atomizing head type coating apparatus **1**, by moving the cartridge transfer device **205**, the cartridge **16** is removed from the coater unit **6**, and the cartridge **16** is mounted on the cartridge support member **32** of the paint replenishing apparatus for a cartridge **31**. At this juncture, the quick joint **23** on the cartridge **16** side abuts against the female coupling portion **33**A of the cartridge support member **32**, while the quick joint **25** abuts against the female coupling portion **33**B of the cartridge support member **32**. As a result, the paint chamber **19** of the cartridge **16** communicates with the paint line **36** on the cartridge support member **32** side, and the extruding liquid chamber **20** communicates with the extruding liquid line **41**. It should be noted that the color A paint which was used in the previous coating operation remains in the paint chamber **19** of the cartridge **16** and the paint supply passage **21**A of the feed tube **21**, respectively.

Next, the operation proceeds to a color A paint discharging step for discharging the remaining color A paint from the cartridge **16**.

In the color A paint discharging step, the trigger valve **26** of the cartridge **16** is first opened. At the same time, the waste liquid passage on-off valve **47** of the paint replenishing apparatus for a cartridge **31** is set to the opening position (b), and the waste liquid adjusting valve **56** is set to the opening position (d), thereby allowing the paint chamber **19** and the waste liquid passage **45** to communicate with the waste liquid tank **46**. In this state, the extruding liquid supply valve **42**B of the extruding liquid supply and discharge device **42** is opened to thereby supply the extruding liquid inside the extruding liquid supply source **43** to the extruding liquid chamber **20** through the extruding liquid line **41**, the quick joint **25**, and the cartridge side extruding liquid passage **24**.

In consequence, as shown in FIGS. **4** and **5**, the piston **18** of the cartridge **16** is pushed by the extruding liquid until the volume of the paint chamber **19** becomes minimal. As a result, almost all of the color A paint remaining in the paint chamber **19** is discharged to the waste liquid tank **46** through the paint supply passage **21**A of the feed tube **21**, the waste liquid passage **45**, the waste liquid passage on-off valve **47**, and the waste liquid adjusting valve **56**, thereby completing the operation concerning the color A paint discharging step.

Here, in the color A paint discharging step, at the time when the color A paint in the paint chamber **19** is discharged to the waste liquid tank **46** through the waste liquid passage **45**, since the quick joint **23** is also in communication, it is conceivable that the color A paint in the paint chamber **19** possibly flows backwardly to the color change valve device **37** side through the paint line **36**. However, since the color A paint at the time when it was replenished in the cartridge **16** remains in the paint line **36**, and the paint valves **37**A, **37**B, . . . , **37**N of the colors A, B, . . . , N, the wash air valve **37**Ar, and the wash liquid valve **37**Lq of the color change valve device **37** are respectively in the closed state, the color A paint which is extruded from the paint chamber **19** is discharged to the waste liquid tank **46** through the waste liquid passage **45** without flowing toward the paint line **36**.

Next, upon completion of the color A paint discharging step, the operation proceeds to a cartridge washing step for washing off the color A paint remaining in the paint chamber **19** of the cartridge **16** and the paint supply passage **21**A of the feed tube **21**.

In the cartridge washing step, the extruding liquid supply valve **42**B of the extruding liquid supply and discharge device **42** is first closed. Since this makes it impossible for the extruding liquid remaining in the extruding liquid passage **24** between the extruding liquid chamber **20** and the extruding liquid supply and discharge device **42** and in the extruding liquid line **41** to flow, the volume of the paint chamber **19** can be kept in a minimal state in the same way as when the color A paint discharging step is completed. At this time, the trigger valve **26**, the waste liquid passage on-off valve **47**, and the waste liquid adjusting valve **56** are in the opened state in the same way as in the color A paint discharging step.

Next, the opening and closing of the wash air valve **37**Ar and the wash liquid valve **37**Lq of the color change valve device **37** are alternately repeated to allow the wash air in the wash air source **40**Ar and the wash liquid in the wash liquid source **40**Lq to be alternately flowed through the paint chamber **19** and the paint supply passage **21**A of the feed tube **21** through the paint line **36**. In consequence, the color A paint remaining in the paint chamber **19** and the paint supply passage **21**A is washed away by the wash air and the wash liquid, and is discharged toward the waste liquid tank **46**, thereby completing the operation concerning the cartridge washing step.

Next, when the cartridge washing step is finished, the operation proceeds to a paint replenishing step for replenishing the color B paint into the paint chamber **19** and the paint supply passage **21**A of the feed tube **21**. The paint replenishing step will be described in order by dividing the step into a feed tube side paint replenishing step of replenishing the color B paint into the paint supply passage **21**A of the feed tube **21** and a paint chamber side paint replenishing step of replenishing the color B paint into the paint chamber **19** of the cartridge **16**.

First, in the feed tube side paint replenishing step, the trigger valve **26**, the waste liquid passage on-off valve **47**, and the waste liquid adjusting valve **56** are continued to be set in the opened state. At this time, the extruding liquid supply valve **42**B and the extruding liquid discharge valve **42**C of the extruding liquid supply and discharge device **42** are in the closed state, so that the volume of the paint chamber **19** of the cartridge **16** is in a minimal state in the same way as in the cartridge washing step.

Next, the color B paint valve **37**B of the color change valve device **37** is opened to supply the color B paint stored in the paint supply source **39** toward the fore distal end of the feed tube **21** through the paint line **36**, the quick joint **23** of the cartridge **16**, and the paint chamber **19**, to thereby replenish the color B paint into the paint supply passage **21**A.

Here, paint undergoes a change in its viscosity in correspondence with its temperature change, as described before. For this reason, paint has the characteristic that when it flows through a conduit, even under the same supply pressure, its viscosity becomes low when the temperature of paint is high, and the discharge rate of paint increases, whereas when the temperature is low, the viscosity becomes high, and the discharge rate of paint decreases.

Accordingly, in the feed tube side paint replenishing step, it is necessary to constantly ensure that the paint is reliably replenished up to the fore distal end of the feed tube **21**. For this reason, by assuming a case in which the viscosity of the paint is highest and the discharge rate is minimum, an arrival time when the color B paint reaches the fore distal end (discharge port) of the paint supply passage **21**A of the feed tube **21** is set as a paint replenishing time on the feed tube **21** side (hereafter referred to as the paint replenishing time) in advance, in correspondence with this minimum discharge rate. However, when the viscosity of the paint is low, the discharge rate of the paint increases, so that a large amount of paint will be discharged and wastefully discarded even within the paint replenishing time.

Accordingly, in the feed tube side paint replenishing step, replenishing is carried out by dividing the step into a fully open replenishing step in which the color B paint is replenished by being supplied toward the paint supply passage **21**A of the feed tube **21** at a large flow rate and a throttled replenishing step in which the color B paint is replenished by being supplied at a small flow rate.

First, in the fully open replenishing step, the waste liquid adjusting valve **56** is kept in the opening position (d) during the aforementioned paint replenishing time, and the color B paint is supplied and replenished into the paint supply passage **21**A with the valve opening fully open. Upon completion of the fully open replenishing step, the operation continuously proceeds to the throttled replenishing step. In this throttled replenishing step, in order to increase pressure loss by decreasing the passage cross-sectional area of the waste liquid passage **45**, the waste liquid adjusting valve **56** is set to the closing position (c) to allow only the throttle passages **62** to be open.

Here, the paint replenishing time is set in correspondence with a discharge rate of the paint which is in the state of a maximum viscosity yielding a minimum discharge rate. Accordingly, the color B paint when its viscosity is high is discharged by only a bare minimum amount from the discharge port of the paint supply passage **21**A of the feed tube **21**, so that the color B paint is not flowed through the throttle passages **62** in the throttled replenishing step.

Meanwhile, when the viscosity of the color B paint has declined and its discharge rate has increased, the color B paint flows beyond the discharge port of the paint supply passage **21**A and reaches the throttle passages **62** of the waste liquid adjusting valve **56** during the paint replenishing time. At this time, however, the discharge rate of the color B paint decreases by being subjected to the action of the pressure loss due to the throttle passages **62**. As a result, when the viscosity of the color B paint is low and the discharge rate has increased, it is possible to reduce the amount of the color B paint discharged wastefully from the feed tube **21**. Thus, the feed tube side paint replenishing step of replenishing the color B paint into the paint supply passage **21**A of the feed tube **21** ends.

Next, the operation proceeds to the paint chamber side paint replenishing step of replenishing the color B paint into the paint chamber **19**. In the paint chamber side paint replenishing step, the trigger valve **26** is closed, and the extruding liquid discharge valve **42**C of the extruding liquid supply and discharge device **42** is opened while keeping the open valve state for the color B paint valve **37**B of the color change valve device **37**. In consequence, the color B paint in the color B paint valve **37**B is replenished into the paint chamber **19** of the cartridge **16** through the paint line **36**, the cartridge side paint passage **22**, and the like. At this time, the extruding liquid in an equivalent amount to that of the paint replenished into the paint chamber **19** is discharged from the extruding liquid chamber **20** toward the extruding liquid discharge line **44** through the extruding liquid discharge valve **42**C.

Meanwhile, while the paint chamber side paint replenishing step is being executed, a waste liquid passage washing step is carried out in parallel with this paint chamber side paint replenishing step. Namely, in the waste liquid passage washing step, the color B paint remaining in the waste liquid passage **45**, the waste liquid adjusting valve **56**, and the like is discharged and washed off. For this reason, in the waste liquid passage washing step, after the waste liquid passage on-off valve **47** is set in the closing position (a) and the waste liquid adjusting valve **56** is set in the opening position (d), the wash air valve **53**Ar and the wash liquid valve **53**Lq of the wash fluid supply device **53** are alternately opened and closed. As a consequence, the wash air from the wash air source **55**Ar and the wash liquid from the wash liquid source **55**Lq are flowed through the waste liquid passage **45** and the waste liquid adjusting valve **56**, and the waste wash liquid is discharged into the waste liquid tank **46**.

As such, in accordance with the first embodiment, in the waste liquid passage **45** communicating with the feed tube insertion hole **34** of the cartridge support member **32**, the waste liquid adjusting valve **56** is arranged to be provided by being located on the downstream side of the waste liquid passage on-off valve **47**. When washing clean the paint chamber **19** of the cartridge **16** and the paint supply passage **21**A of the feed tube **21**, the waste liquid adjusting valve **56** is changed over to the opening position (d) to enlarge the passage cross-sectional area of the waste liquid passage **45**. In consequence, the waste liquid passage **45** allows the wash fluids to be actively flowed, so that the color A paint remain-

ing in the paint chamber **19** and the paint supply passage **21**A can be effectively washed away in a short time.

Moreover, as for the waste liquid adjusting valve **56**, the arrival time when the color B paint reaches the discharge port of the feed tube **21** after being supplied from the color change valve device **37** is set as the paint replenishing time for the feed tube, and this paint replenishing time for the feed tube **21** is set by such conditions as the viscosity of the paint and the length dimension and inside diameter dimension of the supply passage. Accordingly, when the paint replenishing time has been reached, the waste liquid adjusting valve **56** is changed over to the closing position (c) to allow the paint to be flowed only by the throttle passages **62**. In consequence, the waste liquid adjusting valve **56** is throttled such that the passage cross-sectional area of the waste liquid passage **45** becomes small, thereby making it possible to reduce the amount of paint discharged from the discharge port of the feed tube **21**.

As a result, in the cartridge side paint replenishing step of replenishing the color B paint into the cartridge **16**, even in cases where the paint replenishing time varies due to various conditions, the waste liquid adjusting valve **56** is able to narrowly throttle the passage cross-sectional area of the waste liquid passage **45** after the lapse of the paint replenishing time. Therefore, it is possible to reduce the amount of paint which would otherwise be discharged wastefully from the discharge port of the feed tube **21**, thereby making it possible to decrease the amount of paint discarded when the color B paint is replenished.

In this instance, when the color B paint is replenished into the paint supply passage **21**A of the feed tube **21**, the waste liquid adjusting valve **56** widely enlarges the passage cross-sectional area of the waste liquid passage **45** in the fully open replenishing step from the start until before the end of the cartridge side paint replenishing step, and uses only the throttle passages **62** as flow passages in the throttled replenishing step to narrowly throttle before the end of the passage cross-sectional area of the waste liquid passage **45**. As a consequence, in the fully open replenishing step, the color B paint can be speedily replenished into the paint supply passage **21**A of the feed tube **21**, and the replenishing time can thereby be shortened. Meanwhile, in the throttled replenishing step, the passage cross-sectional area is made small, making it possible to reduce the discharge rate of the color B paint which is discarded from the discharge port of the feed tube **21**.

Further, the waste liquid adjusting valve **56** is provided with the recessed groove-shaped throttle passages **62** on the inner peripheral surface **58**A of the valve seat **58**. In consequence, the waste liquid adjusting valve **56** is able to control the valve body **60** between two positions, namely, the opening position (d) and the closing position (c), so that the mechanism can be simplified. Moreover, when the waste liquid adjusting valve **56** is set in the closing position (d), the passage cross-sectional area of the waste liquid passage **45** can be throttled by the throttle passages **62** so as to become fixed each time.

Furthermore, in the paint replenishing method for a cartridge in accordance with the first embodiment, the waste liquid passage washing step for washing the waste liquid passage **45** is provided during the color B paint replenishing step for replenishing paint into the paint chamber **19**, the two steps can be performed in parallel, thereby making it possible to improve the operational efficiency, productivity, and the like.

Next, FIG. **10** shows a second embodiment of the present invention. The characteristic of the second embodiment lies in a construction in which the valve body of the waste liquid adjusting valve is provided with a throttle passage. It should be noted that, in the second embodiment, those component elements that are identical to those of the above-described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

In FIG. **10**, indicated at **71** is a waste liquid adjusting valve in accordance with the second embodiment, and this waste liquid adjusting valve **71** is formed as a two-way and two-position air-driven type on-off valve in substantially the same way as the waste liquid adjusting valve **56** in accordance with the first embodiment. A throttle passage **72** is provided in the valve body **60** of this waste liquid adjusting valve **71**. This throttle passage **72** is formed into a T-shape by a transversal passage **72**A which extends diametrically penetrating the valve body **60** by being located on the proximal end side of the valve body **60** in the valve chamber **57**B and by a longitudinal passage **72**B which extends in the axial direction of the valve inside the valve body **60**, whose proximal end side communicates with the transversal passage **72**A, and whose distal end side is open to a distal end face of the valve body **60**.

According to the second embodiment thus constructed, when the valve body **60** is opened, the waste liquid passage **45** is widely opened, making it possible to speedily replenish paint into the paint supply passage **21**A of the feed tube **21** of the cartridge **16**. Meanwhile, when the valve body **60** is closed, paint is discharged from the transversal passage **72**A of the throttle passage **72** through the longitudinal passage **72**B thereof, thereby making it possible to reduce the paint which is discarded in the feed tube side paint replenishing step.

Next, FIG. **11** shows a third embodiment of the present invention. The characteristic of the third embodiment lies in a construction in which a recessed groove-shaped throttle passage is provided on the outer peripheral surface of the valve body of the waste liquid adjusting valve. It should be noted that, in the third embodiment, those component elements that are identical to those of the above-described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

In FIG. **11**, indicated at **81** is a waste liquid adjusting valve in accordance with the third embodiment, and this waste liquid adjusting valve **81** is formed as a two-way and two-position air-driven type on-off valve in substantially the same way as the waste liquid adjusting valve **56** in accordance with the first embodiment. A throttle passage **82** is provided on the valve body **60** of this waste liquid adjusting valve **81**. This throttle passage **82** is formed as one or a plurality of longitudinal recessed grooves extending in the axial direction by being located on the outer peripheral surface of the valve body **60**. It should be noted that although, in FIG. **11**, two throttle passages **82** are shown, one or three or more throttle passages **82** may be used.

According to the third embodiment thus constructed, when the valve body **60** is opened, the waste liquid passage **45** is widely opened, making it possible to speedily replenish paint into the interior of the feed tube **21** of the cartridge **16**. Meanwhile, when the valve body **60** is closed, paint is discharged through the longitudinal recessed groove-shaped throttle passages **82**, thereby making it possible to reduce the paint which is discarded in the feed tube side paint replenishing step.

Next, FIG. **12** shows a fourth embodiment of the present invention. The characteristic of the fourth embodiment lies in a construction in which throttle passages are provided by axially penetrating the valve seat of the waste liquid adjusting valve. It should be noted that, in the fourth embodiment, those component elements that are identical to those of the above-

described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

In FIG. **12**, indicated at **91** is a waste liquid adjusting valve in accordance with the fourth embodiment, and this waste liquid adjusting valve **91** is formed as a two-way and two-position air-driven type on-off valve in substantially the same way as the waste liquid adjusting valve **56** in accordance with the first embodiment. A throttle passage **92** is provided in the valve seat **58** of this waste liquid adjusting valve **91**. This throttle passage **92** is formed as one or a plurality of through holes penetrating the valve seat **58** in the axial direction by being located on the outer peripheral side of the valve seat **58**. It should be noted that although, in FIG. **12**, two throttle passages **92** are shown, one or three or more throttle passages **92** may be used.

According to the fourth embodiment thus constructed, when the valve body **60** is opened, the waste liquid passage **45** is widely opened, making it possible to speedily replenish paint into the paint supply passage **21**A of the feed tube **21** of the cartridge **16**. Meanwhile, when the valve body **60** is closed, paint is discharged through the throttle passage **92** penetrating the valve seat **58**, thereby making it possible to reduce the paint which is discarded in the feed tube side paint replenishing step. In particular, in the fourth embodiment, since the throttle passage **92** is provided in the valve seat **58** which is a part of the valve casing **57**, special processing with respect to the valve body **60** is unrequired.

Next, FIG. **13** shows a fifth embodiment of the present invention. The characteristic of the fifth embodiment lies in a construction in which the valve casing of the waste liquid adjusting valve is provided with a stopper for holding the valve body in a proximate position which is proximate to the valve seat to thereby form a throttle passage between the valve seat and the valve body so as to allow paint to flow with a small passage cross-sectional area. It should be noted that, in the fifth embodiment, those component elements that are identical to those of the above-described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

In FIG. **13**, indicated at **101** is a waste liquid adjusting valve in accordance with the fifth embodiment, and this waste liquid adjusting valve **101** is formed as a two-way and two-position air-driven type on-off valve in substantially the same way as the waste liquid adjusting valve **56** in accordance with the first embodiment. In substantially the same way as the valve casing **57** in accordance with the above-described first embodiment, a valve casing **102** in accordance with the fifth embodiment has a piston chamber **102**A, a valve chamber **102**B, a valve stem insertion hole **102**C, and an outlet port **102**D. However, the valve casing **102** in accordance with the fifth embodiment differs from the valve casing **57** in accordance with the first embodiment in that a hollow cylindrical stopper **102**E projecting toward the piston **59** is provided in the piston chamber **102**A.

Here, when the valve body **60** is displaced in the closing direction by the urging force of the valve spring **61** by restricting the displacement of the piston **59** in the closing direction, the stopper **102**E is adapted to hold the valve body **60** in the proximate position which is proximate to the valve seat **58**. As a consequence, a throttle passage **103** constituted by an annular gap and having a small passage cross-sectional area can be formed between the valve body **60** and the valve seat **58**.

According to the fifth embodiment thus constructed, when the valve body **60** is opened, the waste liquid passage **45** is widely opened, making it possible to speedily replenish paint into the paint supply passage **21**A of the feed tube **21** of the cartridge **16**. Meanwhile, when the valve body **60** is displaced in the closing direction, the displacement of the valve body **60** is restricted to the position proximate to the valve seat **58** by the stopper **102**E. In consequence, as the paint is discharged through the throttle passage **103** constituted by the gap between the valve seat **58** and the valve body **60**, it is possible to reduce the paint which is discarded in the feed tube side paint replenishing step. In particular, in the fifth embodiment, since the valve casing **102** is provided with the stopper **102**E, special processing with respect to the valve body **60** is unrequired.

Next, FIG. **14** shows a sixth embodiment of the present invention. The characteristic of the sixth embodiment lies in that the waste liquid adjusting valve is constituted by an on-off valve and a throttle passage which are provided separately. It should be noted that, in the sixth embodiment, those component elements that are identical to those of the above-described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

In FIG. **14**, indicated at **111** is a waste liquid adjusting valve in accordance with the sixth embodiment. This waste liquid adjusting valve **111** is constituted by a two-way and two-position air-driven type on-off valve **112** provided in the course of the waste liquid passage **45**, a bypass passage **113** connected to the waste liquid passage **45** by bypassing the on-off valve **112**, and a throttle passage **114** provided in the bypass passage **113**.

According to the sixth embodiment thus constructed, when the on-off valve **112** is set in an opening position (f), the waste liquid passage **45** is widely opened, making it possible to speedily replenish paint into the paint supply passage **21**A of the feed tube **21** of the cartridge **16**. Meanwhile, when the on-off valve **112** is set in a closing position (e), paint is discharged through the throttle passage **114** through the bypass passage **113**, so that it is possible to reduce the paint which is discarded in the feed tube side paint replenishing step. Moreover, as the on-off valve **112** is separated from the throttle passage **114**, an inexpensive two-way and two-position air-driven type on-off valve of standard specifications can be used as the on-off valve **112** of the waste liquid adjusting valve **111**.

Next, FIG. **15** shows a seventh embodiment of the present invention. The characteristic of the seventh embodiment lies in a construction in which, in the feed tube side paint replenishing step, the time when the paint in such a state that its viscosity is lowest and hence its discharge rate is maximum reaches the fore distal end of the feed tube is set as the paint replenishing time, and the waste liquid adjusting valve is throttled through the entire step from the start until the end of replenishing of paint into the paint supply passage of the feed tube such that the passage cross-sectional area of the waste liquid passage becomes small. It should be noted that, in the seventh embodiment, those component elements that are identical to those of the above-described first embodiment will be simply denoted by the same reference numerals to avoid repetitions of similar explanations.

Namely, as in the time chart shown in FIG. **15**, the waste liquid adjusting valve **56** is set in the closing position (c) upon completion of the cartridge washing step, and keeps its closing position (c) in the feed tube side paint replenishing step as well. Accordingly, in the feed tube side paint replenishing step, the waste liquid adjusting valve **56** is continuously closed through the entire step from the start until the end of replenishing, and is thereby throttled such that the passage cross-sectional area of the waste liquid passage **45** becomes small. As a result, in the seventh embodiment, there is no

distinction between the feed tube side paint replenishing step and the throttled replenishing step, and both steps are provided with an identical step of operation.

According to the seventh embodiment thus constructed, in the color A paint discharging step and the cartridge washing step, since the waste liquid adjusting valve **56** is opened, the waste liquid passage **45** can be widely opened to allow discarded paint and wash fluids to be smoothly flowed. In the feed tube side paint replenishing step, on the other hand, since the waste liquid adjusting valve **56** is closed through the entire step, the amount of paint which is wastefully discharged can be made further small although the time for replenishing paint into the paint supply passage **21**A of the feed tube **21** becomes slightly longer. It should be noted that although the waste liquid adjusting valve **56** is used in the seventh embodiment, it is possible to alternatively use other waste liquid adjusting valves **71**, **81**, **91**, **101**, and **111**.

It should be noted that, in the first embodiment, it is explained by citing as an example the case in which the waste liquid passage on-off valve **47** constituted by a two-way and two-position air-driven type on-off valve is provided in the waste liquid passage **45**. However, the present invention is not limited to the same, and may be configured as in the modification shown in FIG. **16**, for example. Namely, a waste liquid passage on-off valve **121** may be constituted by a check valve which allows paint to flow out from the feed tube **21** and prevents its backward flow. This configuration can be similarly applied to other embodiments as well.

Further, in each of the embodiments, it is explained by citing as an example of, as the coating apparatus, the rotary atomizing head type coating apparatus **1** equipped with the rotary atomizing head **9**. However, the present invention is not limited to the same, and may be so configured that, for example, a coating apparatus equipped with an air atomizing nozzle, a hydraulic atomizing nozzle, or the like is used as the coating apparatus.

DESCRIPTION OF REFERENCE NUMERALS

1: Rotary atomizing head type coating apparatus (Coating apparatus)
6: Coater unit
16: Cartridge
17: Tank
18: Piston (Partition wall)
19: Paint chamber
20: Extruding liquid chamber
21: Feed tube
21A: Paint supply passage
26: Trigger valve
31: Paint replenishing apparatus for a cartridge
32: Cartridge support member
33: Tank support portion
34: Feed tube insertion hole
36: Paint line
37: Color change valve device
37A, **37**B, . . . , **37**N: Paint valves of colors A, B, . . . , N
37Ar: Wash air valve
37Lq: Wash liquid valve
39: Paint supply source
40Ar: Wash air source
40Lq: Wash liquid source
41: Extruding liquid line
42: Extruding liquid supply and discharge device
45: Waste liquid passage
46: Waste liquid tank
47: Waste liquid passage on-off valve
53: Wash fluid supply device
56, **71**, **81**, **91**, **101**, **111**: Waste liquid adjusting valve
57, **102**: Valve casing
58: Valve seat
59: Piston
60: Valve body
62, **72**, **82**, **92**, **103**, **114**: Throttle passage
102E: Stopper
121: Waste liquid passage on-off valve (Check valve)

The invention claimed is:

1. A paint replenishing apparatus for a cartridge comprising:

a cartridge for storing paint to be supplied to a coating apparatus, including a tank, a feed tube whose proximal end side is mounted on said tank and whose fore distal end side extends in an axial direction from said tank, a partition wall provided movably in said tank and that partitions an interior of said tank into a paint chamber into which paint is replenished and an extruding liquid chamber to and from which an extruding liquid is supplied and discharged, and a trigger valve for opening and closing a paint supply passage in said feed tube at a fore distal end portion of said feed tube;

a cartridge support member in which a feed tube insertion hole for insertion of said feed tube therethrough is provided so as to extend in the axial direction, and in which a tank support portion for supporting said tank of said cartridge is provided on a side of an insertion port of said feed tube insertion hole;

a color change valve device provided connected to said cartridge support member, and which supplies a paint selected from among paints of a plurality of colors into said paint chamber of said cartridge and said paint supply passage of said feed tube at a time of replenishment of paint, and supplies a wash fluid into said paint supply passage of said feed tube through said paint chamber at a time of washing off of remaining paint;

an extruding liquid supply and discharge device provided connected to said cartridge support member, and which supplies the extruding liquid toward said extruding liquid chamber of said cartridge at the time of said washing and discharges the extruding liquid from said extruding liquid chamber at the time of the replenishment of paint;

a waste liquid passage having one end side provided in communication with said feed tube insertion hole by being located on a bottom side of said feed tube insertion hole of said cartridge support member and another end side communicating with a waste liquid tank;

a waste liquid passage on-off valve provided in said waste liquid passage to open and close said waste liquid passage;

a wash fluid supply device connected to said waste liquid passage and located on an outlet side of said waste liquid passage on-off valve and that supplies a wash fluid for washing clean said waste liquid passage; and

a waste liquid adjusting valve provided in said waste liquid passage by being located on a downstream side of said waste liquid passage on-off valve;

wherein said waste liquid adjusting valve includes a throttle passage, and wherein said waste liquid adjusting valve is configured to widely enlarge a passage cross-sectional area of said waste liquid passage at the time of washing clean said paint chamber and said paint supply passage of said feed tube, and is configured to narrowly throttle the passage cross-sectional area of said waste liquid passage at the time of replenishing paint into said

paint supply passage of said feed tube to allow paint to flow into said waste liquid passage by said throttle passage.

2. The paint replenishing apparatus for a cartridge according to claim **1**, wherein, at a time of replenishing a next color paint into said paint supply passage of said feed tube, said waste liquid adjusting valve is configured to be opened in a state in which the passage cross-sectional area of said waste liquid passage is widely enlarged in advance, and is configured to narrowly throttle the passage cross-sectional area of said waste liquid passage prior to completion of replenishing.

3. The paint replenishing apparatus for a cartridge according to claim **1**, wherein, at a time of replenishing a next color paint into said paint supply passage of said feed tube, said waste liquid adjusting valve is configured to narrowly throttle the passage cross-sectional area of said waste liquid passage continuously from a start to an end of replenishing.

4. The paint replenishing apparatus for a cartridge according to claim **1**, wherein said waste liquid adjusting valve includes a valve casing including a valve seat in said waste liquid passage and a valve body seated on and unseated from said valve seat, and said throttle passage is configured to allow paint to flow therethrough with a small passage cross-sectional area in a closing position in which said valve body abuts against said valve seat.

5. The paint replenishing apparatus for a cartridge according to claim **1**, wherein said waste liquid adjusting valve includes a valve casing including a valve seat in said waste liquid passage and a valve body seated on and unseated from said valve seat, and

said throttle passage is configured to allow paint to be flowed therethrough with a small passage cross-sectional area between said valve seat and said valve body by providing a stopper formed on said valve casing and holding said valve body in a proximate position which is proximate to said valve seat.

6. A paint replenishing method for a cartridge for replenishing paint to be supplied to a coating apparatus into a cartridge that includes a tank into which the paint is replenished, a feed tube whose proximal end side is mounted on said tank and whose fore distal end side extends in an axial direction from said tank, a partition wall provided movably in said tank and that partitions an interior of said tank into a paint chamber and an extruding liquid chamber, and a trigger valve for opening and closing a paint supply passage in said feed tube at a fore distal end portion of said feed tube, said paint replenishing method for a cartridge comprising:

a previous color paint discharging step of discharging a previous color paint remaining in said paint chamber of said cartridge to a side of a waste liquid passage connected to a discharge side of said feed tube;

a cartridge washing step of washing off the previous color paint attached to said paint chamber of said cartridge and said paint supply passage of said feed tube;

a feed tube side paint replenishing step of replenishing a next color paint in a state in which a discharge rate of the paint from said paint supply passage is decreased by narrowly regulating a passage cross-sectional area of said waste liquid passage and allowing paint to flow into said waste liquid passage by said throttle passage when the next color paint is replenished into said paint supply passage of said feed tube; and

a paint chamber side paint replenishing step of replenishing the next color paint into said paint chamber of said cartridge in a state in which said waste liquid passage is closed upon completion of replenishing of the next color paint into said paint supply passage of said feed tube.

7. The paint replenishing method for a cartridge according to claim **6**, wherein, in said feed tube side paint replenishing step, the next color paint is arranged to be replenished in a state in which the discharge rate of the paint from said paint supply passage is increased by widely regulating the passage cross-sectional area of said waste liquid passage in advance, and prior to completion of replenishing the discharge rate of the paint from said paint supply passage is decreased by narrowly regulating the passage cross-sectional area of the waste liquid passage.

8. The paint replenishing method for a cartridge according to claim **6**, wherein, in said feed tube side paint replenishing step, the passage cross-sectional area of said waste liquid passage is arranged to be narrowly throttled through an entire step of replenishing paint into said paint supply passage of said feed tube.

9. The paint replenishing method for a cartridge according to claim **6**, further comprising a waste liquid passage washing step of washing clean said waste liquid passage while said paint chamber side paint replenishing step is being executed.

10. The paint replenishing method for a cartridge according to claim **7**, further comprising a waste liquid passage washing step of washing clean said waste liquid passage while said paint chamber side paint replenishing step is being executed.

11. The paint replenishing method for a cartridge according to claim **8**, further comprising a waste liquid passage washing step of washing clean said waste liquid passage while said paint chamber side paint replenishing step is being executed.

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